Bell Telephone

PRIVATE ENTERPRISE AND FREEDOM FROM WANT

BELL SYSTEM SCHOOLING FOR SERVICE MEN

A DIAL SWITCHING SYSTEM FOR TOLL CALLS

"PACKAGED CARRIER" FOR THE SIGNAL CORPS

INFORMATION ABOUT "INFORMATION"

ELECTRIC BRAIN

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Winter 1943-44

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"The ideal and aim of the American Telephone and Telegraph Company and its Associated Companies is a telephone service for the nation, free, so far as humanly possible, from imperfections, errors, or delays, and enabling anyone anywhere to pick up a telephone and talk to anyone else anywhere else, clearly, quickly and at a reasonable cost."

A Medium of Suggestion & a Record of Progress

Published for the supervisory forces of the Bell System by the Information Department of AMERICAN TELEPHONE AND TELEGRAPH COMPANY, *195 Broadway, New York, N. Y.*

Who's Who & What's What

in This Issue

IT WAS in 1904 that WALTER S. GIFFORD (whose picture appears on page 211) joined the Bell System as a clerk in the payroll department of the Western Electric Company in Chicago. The following year he was transferred to New York, becoming assistant secretary and assistant treasurer of the company. In 1908 he joined the American Telephone and Telegraph Company, and from 1911 to 1916 was its Chief Statistician. Returning to the company in 1918, from his war-time responsibilities, he was appointed Comptroller. In 1919 he was elected a Vice President; in 1923, Executive Vice President and in 1925, President.

Early in 1916, at the request of the Naval Consulting Board, Mr. Gifford directed the work of the National Industrial Preparedness Campaign. Late in that year Congress created the Council of National Defense, and from December of 1916 to November of 1918 he was Director of both the Council and its Advisory Commission. In July of 1918 he went to Paris, where he served for four months as Secretary of the American section of the Inter-allied Munitions Council.

At present, Mr. Gifford is Chairman of the Industry Advisory Committee of the Board of War Communications.

Concerning Mr. Gifford's many charitable, educational, and scientific interests it is perhaps sufficient to cite that in 1938 he received the gold medal of the National Institute of Social Sciences in recognition of his services "as Director of the Council of National Defense; President of the Charity Organization Society of New York; Trustee of Johns Hopkins University, General Education Board, Carnegie Institution of Wash-

Mr. Dixon

Mr. Hosford

Mr. Baker

Mr. Parker

Mr. Kostkos

ington; Director of the President's Organization on Unemployment Relief; President of the American Telephone and Telegraph Company, the greatest non-governmental organized service in the United States; and as trustee of numerous educational and scientific foundations." The Franklin Institute's citation accompanying the Vermilye Medal, quoted on page 211, is but the most recent of similar honors.

THE PLANT training and personnel work which ALLAN R. DIXON of A. T. & T.'s plant operation division was carrying on with the operating companies before the war is much a-kin to the type of instruction given to military personnel in Bell System plant schools. Mr. Dixon has been intimately concerned with the war training activities he describes ever since they began to take shape as an organized program. Starting with the Chesapeake and Potomac Telephone Company in Washington in plant engineering work in 1921, Mr. Dixon transferred in 1926 to the Department of Operation and Engineering of the A. T. & T. Company, where in the plant operation division he worked on plant practices assignments until 1931. For the next six years he was in the sales section of the commercial division, and returned to the plant operation division in 1937.

IT IS an undertaking of momentous potentialities for the future as well an an important present project which HOWARD L. HOSFORD describes in his article on a dial switching system for toll calls. Since joining the Long Lines Department as a traffic student in 1920, Mr. Hosford has had assignments in all four Long Lines traffic divisions. He became Division

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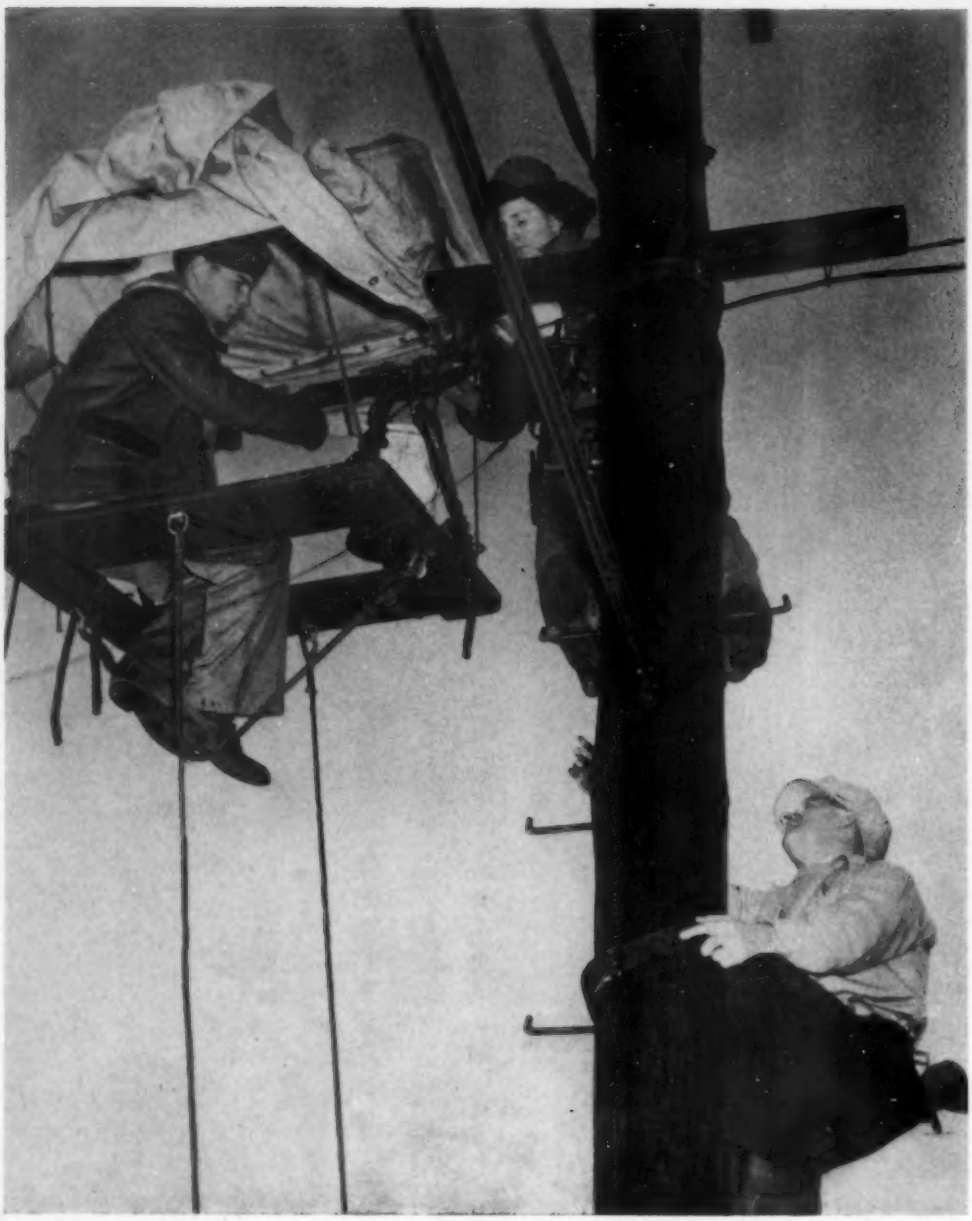


TWO MARINE CORPS STUDENTS make a practice repair on a plant school telephone cable as an operating company instructor supervises their work. See "Bell System Schooling for Service Men," beginning on page 215

The Head of the Bell System Gives His Views on Managerial Responsibility in the Post-War Period and on the Course of Business in the Democracy Which Is America

Private Enterprise and Freedom from Want

Walter S. Gifford

The following is the text of an address delivered by Mr. Gifford on November 9, 1943, on receiving the Vermilye Medal, which is awarded biennially by the Franklin Institute, of Philadelphia, to individuals "in recognition of outstanding achievement in the field of industrial management."

I AM GLAD that there is a medal in recognition of industrial management and I am happy and honored to receive the Vermilye Medal with your generous citation. For nearly a century and a quarter the Franklin Institute has closely surveyed the fields of science and technology; and no man could fail to be pleased to learn that his endeavor to afford effective management to a business enterprise which involves the extensive application of those forces finds favor with you.

The art of living may be a higher art than the art of making a living, but the art of making a living is quite fundamental to the happiness of mankind. Industrial management has enabled great numbers of people to combine their talents and vastly increase their effectiveness. It has made possible wide-spread use of the inventions of mankind. It has played a vital part in the rise of mankind from the certainty of want to the possibility of plenty and this change has come in the last 150 years. This change was generated in the lands where political and industrial freedom were greatest and where man and management had the greatest opportunity.

It has been one of the most sensational improvements in the lot of mankind since the dawn of history.

But it has not produced Utopia, nor a perfect race of human beings, nor has it stopped war, nor has it guaranteed complete employment for everyone at any and all times.

IN THIS very human world our country leads in many ways; in none perhaps more than in the art of management. Yet management was for some years prior to the war not only the "forgotten man" but the much abused man. It was wrongly blamed for much during the depression years. Fortunately the criticisms and attacks were not too destructive. I say fortunately because it has been largely the skill and leadership of American management directing American labor and capital that have made it possible for America to become the Arsenal of the United Nations in this global war.

The achievements of American industry before the war and since have been nothing short of miraculous. Right now, measured by output per worker, we produce half as much again as Canada and twice as much as Great Britain or Germany and three to four times as much as Japan. Precisely how much of that is due to American management and how much to the American worker or to American capital, no one can tell, but clearly the ingenuity and resourcefulness of American management have played an outstanding part in furnishing our armed forces a quality and quantity of equipment that give them better than an even break with the enemies who were preparing for war years before we started.

When the war began, the United States, with only one-sixteenth of the world's population, had more automobiles than all the rest of the world combined, and as many telephones. We had over one-third of all the radio sets and about one-third of all railroad mileage in the world. We were the leading nation in the world in air transport. We were producing about one-third of all the electric power and also about one-third of all the steel produced in the world. Since the war began we have with extraordinary speed converted our peace-time industries into war industries and increased our output so that our present war production is more than half again as large as that of Germany and Japan combined.

The tonnage of merchant ships completed in September, 1943, was 25 times the tonnage produced in the same month two years ago. Also, more than 2,380 fighting ships and auxiliaries of all kinds have been completed since May, 1940, and in addition 13,000 landing vessels. The Navy Department says, "No naval construction program of comparable size and speed has ever been accomplished by any other nation."

I KNOW of no more typical American story than the history of the airplane. Two brothers who made their living by mending bicycles in a medium-sized town, invented it. They lived in a free country where inhibitions were few, where anyone could try anything, where invention and industry were encouraged. Such things happen more often in the free atmosphere of America than elsewhere. Likewise, this atmosphere invigorates industrial management so that when war came the airplane industry here was able to expand so rapidly that we now lead the world

with the production of more than 8,000 airplanes a month; probably at least twice the output of the Axis Nations, and as much as that of the other United Nations and Axis Nations combined. And what is more, we can keep up and even increase the quantity of production and at the same time change to new and better types to a degree and with a speed our enemies cannot match. The teamwork of research, design, engineering and production is one of the most notable achievements of American industrial management.

MR. GIFFORD (left) receives the Vermilye Medal from Charles S. Redding, President of Franklin Institute. The citation accompanying the medal reads: "To Walter S. Gifford, President of the American Telephone and Telegraph Company, who throughout the past two years of war has directed the managerial affairs of the Bell Telephone industry in such a way as to afford singular satisfaction to the users of the service, to the employees of the organization, to the owners of the property and to the public at large; admirably meeting a greatly increased demand for the telephone service in face of sharp limitation of priorities on materials and men, and devoting the entire resources of his company's research laboratories as well as the great part of its manufacturing establishment to the special requirements of the armed forces of this country and of its allies."

Nearly everyone on the home front has a son, husband, friend or sweetheart in the armed forces and they,

as well as those on the fighting fronts, have a vital interest in this job that American industry is doing. In fact, modern warfare is so much a matter of ships, airplanes, tanks, guns and electrical and mechanical gadgets that success is bound to come in the long run to those who have the will to win and can produce the most; and the shorter the time needed to produce, the quicker the victory. We Americans can be proud of the record we are making in our war-time production.

BUT HOW ABOUT the post-war world? One of the freedoms of the Atlantic Charter is Freedom from Want. Clearly there is no country in the world that is as free from want as ours. I refer to what I think the drafters of the Atlantic Charter meant—freedom from hunger and cold. That type of freedom from want, America has already largely achieved; indispensible in this achievement have been the skills of management and management's ability to put to practical use the increased knowledge of science and research. The scientists have pushed back the frontiers of knowledge. They have been encouraged to do that and their results have been put to practical use by management. Moreover, although all scientific discoveries are available ultimately to all the peoples of the world, somehow we in America have made the most use of them. It is because of the genius of the American people and especially, I believe, because of the genius of American industry given free rein in a free country.

There is no question but that we have come nearer to securing freedom from want than any other country in the world. We had enough food, clothing and shelter for all even in the depths of the depression. In fact, government programs were put into effect to reduce wnat was called over-production of food. Today we are supplying ourselves and our armed forces with food and clothing and at the same time are shipping large amounts to our Allies on Lend-Lease. But a standard of living that consists merely of enough of the necessities of life to go around even in a depression, or enough to spare to send great quantities to our Allies in war-time, is not a satisfactory goal for Americans. Man does not live by bread alone. It is the frustration, the terrible feeling of futility, that defeats human beings in our country when mass unemployment makes it necessary for them to live "off the government." In our America, the dignity and worth of the individual are of prime importance.

WE AMERICANS strive for not only freedom from want and a high standard of living, but for equal opportunity for all; for opportunity for a job, opportunity for each one of us to develop and enjoy to the utmost our innate abilities—in short, opportunity to make the most of ourselves. And we want for each new generation the opportunity to marry young and bring up their children with even better opportunities than we had. America, the land of private enterprise, still leads the world in freedom from want, in its high standard of living, and as the land of opportunity. This is not just because of an abundance of natural resources. Other countries have an abundance of na-

tural resources. It is because we have made better use of our natural resources. I am convinced that this is because we have encouraged private enterprise and have striven to keep opportunity open to each and every one of us. In this way we have developed our skilled management that has come more often than not up from the ranks. In the organization with which I have been associated for nearly forty years, management, from foreman and supervisor to president, has been drawn almost entirely from the ranks. In fact, all of the top executives started at the bottom. This is true generally of American industry. Worker and management are largely the same people in America—only at different stages of their careers. If ability is there, the way has been open for a man to rise from whatever point he starts.

THERE ARE, of course, many millions of persons who make the most out of their lives in ways and careers that are remote from business as such. These people, whether they realize it or not, are dependent upon business for their opportunity to make the most of themselves in the field of their choice; for without the production of at least the necessities of life in abundance for all, only a few—too few—can be free to follow pursuits not directly connected with the production of food, shelter and clothing.

It would be ridiculous to be satisfied with the progress we have made toward freedom from want and toward opportunity for everyone—but we can have the satisfaction of knowing that our progress has been greater than that of any other country. There is much to be done to make life after the war more livable for millions of our fellow citizens. It calls for the best thought of all of us and the answer, or rather answers, for I expect there are many, are not easy. It is unbelievable, however, that we shall be so short-sighted that because we had mass unemployment in a period of depression that was world-wide and because we have not yet reached perfection, we should tear down and destroy the very basis of the relatively high standard of living and equality of opportunity which we already possess.

WITHOUT FREEDOM of individual enterprise we would, I am sure, lose our high standard of living and cease to be the land of opportunity. We would lose our world leadership and we would greatly weaken our national safety; for we might well no longer be the strong, resourceful nation able to surpass any other nation or combination of nations in the production of the weapons of modern warfare, so vital for defense. Let us not forget that we always have had and will continue to have competition from other countries. Clearly our safety and our well-being depend upon the fullest encouragement to American ingenuity, upon maintenance of our system of freedom of private enterprise. In fact, I strongly suspect that this freedom is basic and that, without it, in the long run other freedoms cannot exist.

Industrial management is concerned with producing more for all—not merely dividing up what we have. To be successful it requires technical skill, but it requires more than that.

It requires the leadership that can only come from faith in the worth of the individual, from confidence in the future of our democracy and its encouragement of private enterprise and confidence in the ultimate solution of problems, no matter how difficult. I believe much of our recent pre-war troubles were due to a wide-spread defeatist attitude on the part of people generally. I am not referring to those people who were unemployed and had a real cause for despair. It would be difficult to overestimate the damage done by this defeatist attitude and it was so un-American that it was hard for me personally to understand it. We must approach our post-war problems more realistically. To expect wide-spread unemployment and the end of private enterprise is, in my view, not being realistic. It is more realistic, I believe, to expect plenty of employment and the abandonment of government war-time controls, including taxes that discourage enterprise, as rapidly as practical with resulting further progress in improving our standard of living and in providing equal opportunities for all. Defeatism has no place in America. I know many who are responsible for management of large and small business enterprises. I know none who are not confident of the post-war future. It is with such confidence that management has accomplished so much in the past and will, if not unnecessarily hampered, accomplish so much in the future.

I look forward to good times, to good wages—to a period that will create capital and well-being. That is the usual history of our people. In that creative progress industrial management is one of the important forces. I am proud to be an officer in the army that is producing the wherewithal with which the fighting men will win victory over the Axis—over the planners of National Socialism in Germany and Fascism in Italy and Militarism in Japan and which likewise will produce the wherewithal with which Americans can continue to win victories over poverty and want as they have since the Constitution set up that liberty which insures economic opportunity. Let us have faith in the democratic way—the way of America.

ON THE WHOLE, it seems to me that the organization of modern business, of which the Bell System is but one example, which mixes reason with authority and routines with initiative so that more than a quarter of a million people can engage in a complicated art, each using his or her brains, and yet have the whole thing move toward a desired end without confusion, is as significant as the discovery of new facts about nature that allow what is called technological progress.

From "The Bell Telephone System," by Arthur W. Page, Vice President, A. T. & T. Co. Harper & Brothers, publishers, 1941.

The Operating Companies' Long-established Plant Schools Have Given Instruction in Communication to Thousands of Men from All Branches of the Armed Forces

Bell System Schooling for Service Men

Allan R. Dixon

WHEN THE JAPS were first blasted out at Guadalcanal, United States Marines promptly grabbed the telephone exchange serving the airport which was soon to become Henderson Field. The switchboard, of Nazi make, was connected to open-wire lines which fanned out to all parts of the island. After the terrific shelling by the American forces, these lines were reduced to a tangled mass of wire in the surrounding jungle. American ingenuity and skill soon restored all this to working order. When the leathernecks celebrated the "cut-over" to American operation, they tacked up a sign outside the door of the exchange which read, "Guadalcanal Tel. & Tel."

Since "Guadalcanal Tel. & Tel." came into being, many more additions have been made to the United States military network which is the world's fastest growing communication system. Centered like a giant web in the Army's Pentagon Building at Washington, this network reaches out across land and sea to link up our forces in all theaters of war. Five thousand tons of copper a month (an amount comparable to normal Bell System peace-time usage) go into expanding and interconnecting it. Equipment of all kinds is needed at outlandish terminal points: a high-powered radio at Algiers, repeater stations along the Alaska Highway, teletypewriters on the flat-tops and battle wagons, direction finders in Iceland, and subsidiary networks to serve military needs in occupied territories.

To put such a system together and make it work takes an almost endless number and variety of skilled personnel. It has been said that one man out of twenty in our ten-million-man fighting force is needed for the communication services. Most of these men require special training in com-

HOW SIGNAL CORPS TRAINING IS PLANNED AND COORDINATED

HEADQUARTERS ARMY SERVICE FORCES
Director of Military Training

OFFICE OF CHIEF SIGNAL OFFICER

Programs of training requirements in each of the Service Commands are prepared to indicate number of men to be trained, courses required and completion dates of classes, to meet Army schedules.

Standards are established as to qualifications of students, content of courses, and service ratings of students on graduation.

ARMY SERVICE COMMAND	HEADQUARTERS
1ST	BOSTON
2ND	NEW YORK CITY
3RD	BALTIMORE
4TH	ATLANTA
5TH	COLUMBUS
6TH	CHICAGO
7TH	OMAHA
8TH	SAN ANTONIO
9TH	SAN FRANCISCO

Following approval of training programs prepared by the Office of the Chief Signal Officer, schedules of classes of trainees are arranged between each service command and the nearby Bell Operating Companies.

BELL OPERATING COMPANIES

- NEW ENGLAND
- SOUTHERN NEW ENGLAND
- NEW YORK
- NEW JERSEY
- PENNSYLVANIA
- CHESAPEAKE & POTOMAC
- SOUTHERN
- OHIO
- CINCINNATI & SUBURBAN
- MICHIGAN
- INDIANA
- WISCONSIN
- ILLINOIS
- NORTHWESTERN
- SOUTHWESTERN
- MOUNTAIN
- PACIFIC
- LONG LINES DEPARTMENT

Trainees from the various service commands are trained in vocational schools in the nearest Operating Company having available school facilities. Flexibility in scheduling classes is provided through direct contact between the Operating Company and the Local Service Command.

A. T. & T. GENERAL STAFF

Surveys are made to determine available school capacities in the various Operating Companies. Programs are prepared in coordination with the Office of the Chief Signal Officer to match Army requirements with available school facilities.

munication work to fit them for duty. The training of so many thousands of communication specialists is a stupendous job.

The training problem was particularly acute in the year following this country's entry into the war. In that year—1942—the needs of the growing Army threatened to outstrip the capacity of the training facilities at the Army Signal schools. Every available facility for training, industrial as well as military, was called upon to assist.

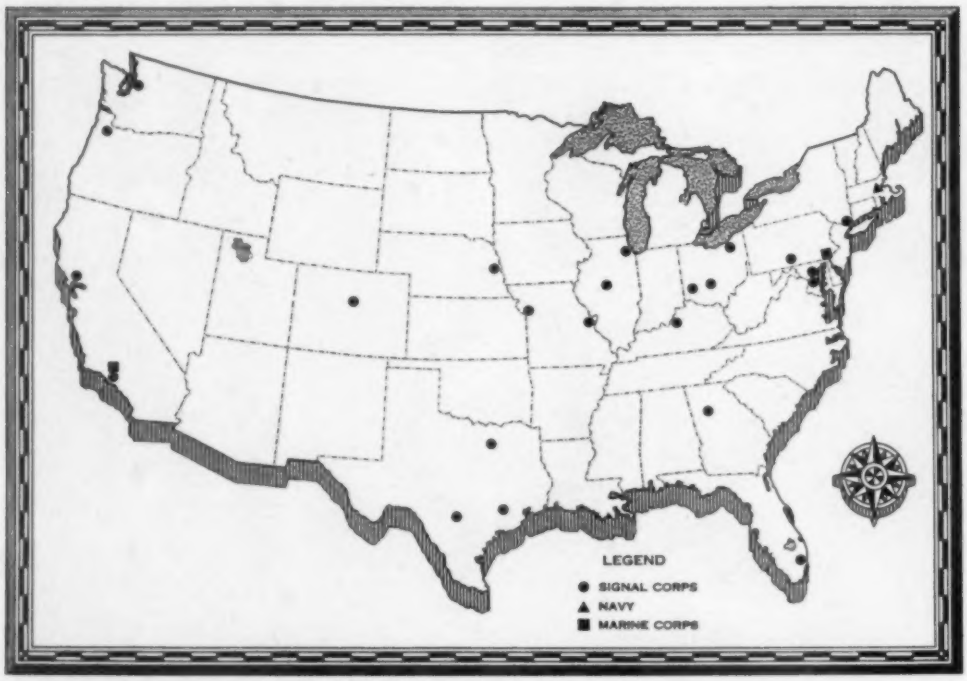
It was a most natural thing that the Bell System, with its long established training schools and instructor staffs, should volunteer to assist the Signal Corps in its communication training program. That help was later expanded to include other Service branches. In 1942, more than 4,000 service men—soldiers, sailors, and marines—attended communication courses conducted in Bell System plant training schools by Bell System instruction staffs. This year (1943) there will be many more, to keep pace with expanding military requirements.

IN THIS GROUP are 38 Marine Corps students, 97 Army Signal Corps students, and 21 telephone company instructors. This is one of the largest groups to receive Bell System training

Broadly speaking, there have been two principal reasons for the Bell System's part in the over-all military communication training pro-

gram. The first was to take the "overflow" from the Signal schools at the time when their own facilities were overtaxed by the expanding demands. The second was to provide special technical courses in which telephone craftsmen might be called upon to help in the war training program. But it was difficult to foresee the extent and direction in which assistance could best be rendered.

The first requests received for



LOCATIONS OF the principal Bell System schools for training service men

phone company instructors and facilities are especially qualified to render training assistance without entailing costly delays. A glance at the map on this page shows that nearly all Bell System companies have had a part in this program.

Before Pearl Harbor

IT BECAME increasingly evident, in the days before Pearl Harbor, that Bell System schools for training installers, repairmen, and other telephone company instructors and facilities are especially qualified to render training assistance without entailing costly delays. A glance at the map on this page shows that nearly all Bell System companies have had a part in this program.

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The first requests received for training assistance were handled purely on a local basis between the Bell operating company and the local service command. Usually such requests reached the various Bell operating companies by way of the local Army Signal Officer in a nearby camp with a group of men in his outfit who needed a little brushing up on telephone and switchboard circuits in use about the army post. Help of this sort was given wherever it was requested, and this early experience, as

it turned out later, was a good thing. It gave the training staffs in the Bell companies an opportunity to become better acquainted with Army personnel at the camps and Signal schools, and to learn about Army training methods and requirements.

As these requests for assistance became more frequent, the staff organization of the American Telephone and Telegraph Company sensed the need for a more unified program of Bell System instruction for service men, and arranged for conferences between the Associated Company men responsible for training and officers of the Army's general staff in Washington having similar responsibilities. The System men were also invited to visit the Eastern Signal Corps School at Fort Monmouth. Out of these closer and more personal contacts the telephone men achieved a better understanding of Army training courses and methods and a clearer picture of the Army's objectives and how the telephone courses could contribute to them.

Despite the doubts and uncertainties which plagued so many activities prior to American entry into the war, considerable help was rendered by telephone company schools to the armed forces even in 1941. In that year instruction was given by the telephone companies to quite a number of service men, and training staffs throughout the System were gaining valuable experience for what was to come.

TELETYPEWRITER CLASSES are kept small in numbers so that the instructor may give more attention to individual students

Meanwhile, as the handwriting on the wall became increasingly more legible, coöperation between the tele-

phone companies and the office of the Chief Signal Officer in Washington resulted in comprehensive plans to make fully available to the nation's armed forces the Bell System's training facilities and teaching staffs for courses in communication.

The System's Own Training Schools Were Available

IT SHOULD be noted here that the Bell System's program for training its own telephone craftsman and technical men is one of long standing and is designed to meet the current needs of the business. Each of the operating companies conducts organized courses for training telephone installers, linemen, cable splicers, and other skilled telephone men. In the larger cities these courses are given in regularly established telephone company schools provided with a complete complement of telephone equipment and staffed with instructors who are experts in their particular fields. In smaller places, training is carried out in temporary schools or on the job, as the occasion requires.

In the over-all, these Bell System facilities and instructors constitute an immediately available reservoir which could be tapped for use by the military forces wherever training needs might arise. Since Army courses of instruction parallel closely those given in the telephone company schools, the adaptation of these company schools to training of service men has been accomplished with a minimum of delay.

In working out a training program with the Office of the Chief Signal Officer, the A. T. & T. training staff suggested a few simple ground rules based on earlier experience.

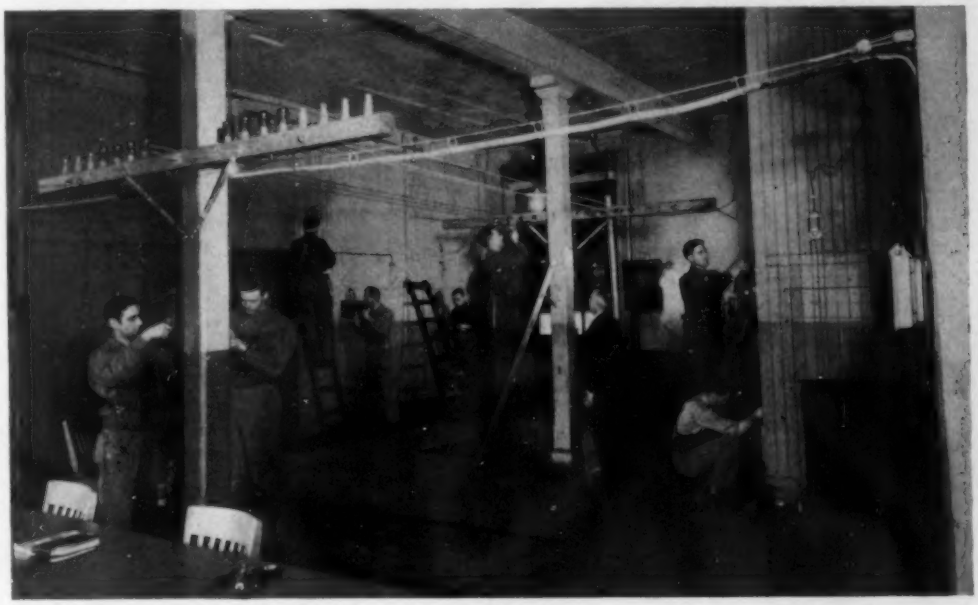
Requests for training assistance, it was agreed, would be initiated by military headquarters in Washington having a view of the over-all requirements. These requests are directed to the A. T. & T. Co. in New York, where decisions can be worked out as to which of the System operating companies are in the best position to carry out the training on specific projects. In this way full use is made of existing telephone company schools throughout the System before expanding school facilities and instructor staff at any one location. This, of course, helps to avoid overtaxing the facilities of individual Bell companies, particularly those having in their territories the heaviest concentrations of new camps and war industries. It was further agreed that training undertaken would be on a programmed basis, and would be focused on services which the System was best adapted to render.

THESE WERE the main considerations. There were, of course, other problems to be worked out as the program developed. Principal among these were the usual war-time scarcities of equipment and manpower; shortages of school equipment, such as teletypewriters, which are proving such a boon to military communications; shortages of school space; and shortages of instructors. Many telephone company instructors were already in the armed forces, or engaged in training new recruits and upgrading craftsmen in the telephone business.

What happened on December 7, 1941, called for prompt action. It was vital to avoid being too late. Over night, surveys were rushed in to

A. T. & T. headquarters from the Associated Companies to help line up training schedules. Priority requests for school equipment flashed over the A. T. & T. lines to Washington. Plane shipments of instructors and equipment sometimes helped to push back the hands of the clock. The airport at Chicago on one occasion held up a stratoliner for a bulky package of school apparatus en route to a company school on the Pacific Coast. They had to take the door off the plane to squeeze it through. But the service men graduated from school on time to sail with their outfit and that was what counted. Sometimes the Army would lend the telephone company new equipment needed for training, only to snatch it back a bit later to meet more urgent needs at the front.

Some of these initial hurdles occurred immediately following Pearl Harbor; but plans for the handling of training arrangements quickly shaped up along lines graphed on page 216.



STUDENTS LEARN to install telephones and maintain lines by practicing with actual equipment in telephone company class rooms

Training for Spiral-4

ONE OF THE FIRST JOBS the Bell System took over at the request of the Signal Corps was instruction needed on "Spiral-4." The Spiral-4 system operates over four wires tightly encased in a rubber sheathing to form a cable not much thicker than a lead pencil. Miles of this cable can be reeled off a speeding truck

to bridge long gaps between the larger headquarters at the front. Telephone carrier and repeater equipments are used to boost up the message capacity to three voice channels and four telegraph channels—all working on just two pairs of wire. In the last war, it took miles of open-wire pole line across Flanders fields to do much the same kind of job.

SIGNAL CORPS technicians, called repeatermen, are needed to hook up Spiral-4 and make it work. The Army said they wanted their men given a thorough grounding in electronics and telephone transmission, backed up by practical experience in connecting and tuning up circuits and equipment similar to that used on regular long lines networks in the Bell System.

In a brief few weeks after this project was put up to the Bell System, courses of instruction were "tailor made" by the Long Lines Department, and instructors and schools were mobilized throughout the country. Trainees in groups of twenty service men at a time were selected from the Army Signal Schools and shipped in to a series of classes held at test rooms in Denver, Chicago, Louisville, West Palm Beach, San Francisco and other places wherever openings could be found. Telephone company instructors sometimes shuttled back and forth across the country to fit in with the shifting tides of available facilities which controlled the locations of classes from month to month. Army trainees totaling over a thousand men have since been turned out from these schools in time to join activated units bound for service overseas.

The Alaska Highway communication system found the need in recent months for more repeatermen, and the Western Defense Command sent trainees to a special school that Long Lines opened for them at Denver. In this case the Signal Corps decided that some on-the-job training would be worth while. To handle this, the instructors from the Denver school packed their bags for a northern climate and worked right along with their Army students who were assigned to the 15 repeater stations on the 1,375-mile line between Edmonton, Alberta, and White Horse in the Yukon territory.

Pulling Together

AN INTERESTING side-light on these training projects is the opportunity they present for team-work between various units of the Army and the Bell System.

An illustration of how this team-work comes into play is the case of Spiral-4. Advance estimates were made of the number of equipment units required and their scheduled delivery dates at embarkation ports. Parallel estimates were made of the number of skilled men needed to service the equipment at points where it might be used overseas. From these estimates, manufacturing and training schedules were coördinated so that trained service men would be available at the time equipment was ready for shipment.

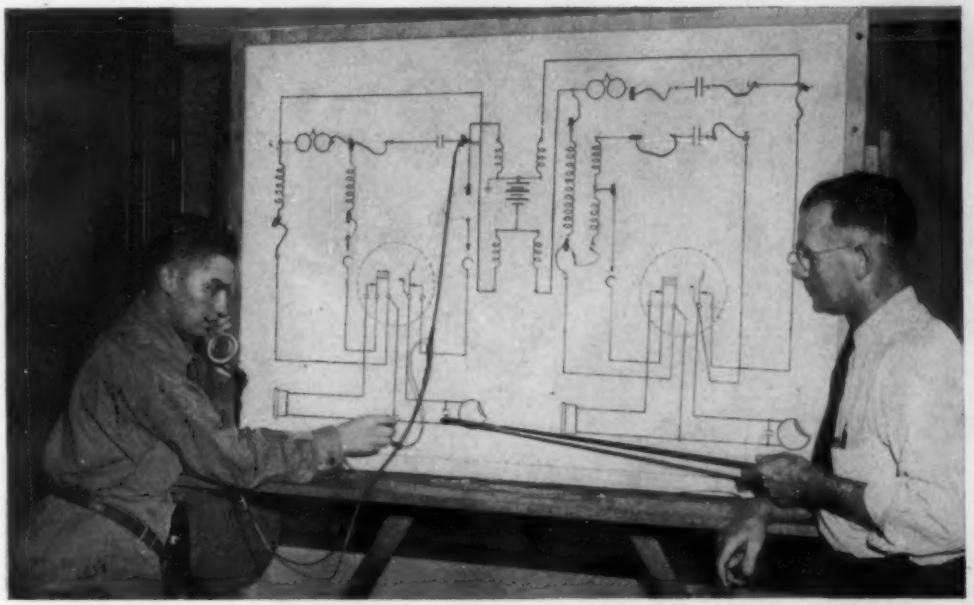
In this coöperative effort, the Bell Laboratories carried the torch in design work, Western Electric in manufacture, Long Lines and Associated Companies in training, and the A. T. & T. general staff in engineering and coördination. Working hand in glove

with telephone people were Army officers assigned to similar work in the Signal Corps like the technical staff at the Signal Corps Laboratories at Fort Monmouth; the staff officers in the Military Training Division, Army Service Forces, and in the Office of the Chief Signal Officer in Washington; and those serving on signal assignments in the various Service Commands throughout the country.

The same kind of coördination has been worked out with the Navy and other branches of the Service. Organization of the Bell System, with its line and staff set-up, bears a close resemblance to that of the armed forces. This has gone a long way to supplement the fine spirit of coöperation and teamwork between the two organizations.

Basic and Advanced Courses

THE REPEATERMEN trained for Spiral-4 and for the Alaska communication system comprise a large group of service men trained in Bell System schools, but they represent just one of the many kinds of skilled craftsmen turned out by these schools. For the Navy and the Coast Guard most of the training has been on teletypewriter and radio telegraph systems, to take care of expanded overseas operations. Courses for the Coast Guard personnel include maintenance of facilities for shore patrol anti-submarine and aircraft warning services needed along remote coastal



DEMONSTRATION BOARDS help the service man to visualize telephone circuits. This board is wired to reproduce "trouble" of various kinds

sections to supplement land line facilities.

For the Marines, as well as for the Signal Corps, land lines and wire systems come into play and a much wider range of subjects has been taught. Most of these courses for installer-repairmen, switchboard men, linemen and allied crafts, have been conducted in schools of the Associated Companies to take care of "overflow" from the Signal Schools and to meet the needs of the various Service Commands in different parts of the country. Now that the Signal Schools have expanded their school facilities to a point where they can carry out most of this type of instruction at their war schools, the general level of this type of activity in Bell System schools has been reduced, and most of the classes now running are in advanced work. The Bell Telephone Laboratories, too, has made substantial contributions to training of technical men in the armored forces in connection with radio sets for tanks, and special devices. Much of the training at the Laboratories cannot be discussed until the close of the war.

To provide an over-all view of the part played by Bell System schools, the principal subjects covered are listed in the box at the right.

Teaching Methods

How do the military people view the Bell System's training job? The following, quoted in part from a letter from a Signal Officer in one of the Corps Areas, is perhaps a typical response:

"Many favorable comments have been received in this office from Signal Officers throughout the Third Corps Area regarding the fine training given to enlisted personnel from the Signal Corps at the recent courses of instruction conducted by Associated Companies of the Bell System. Although these courses were for only four to six weeks' duration, a great improvement has been noted in the ability of the men receiving this training, not only to perform their normal duties but to assume additional duties and responsibilities."

Similar comments have been made by other staff officers on inspection trips through Bell System schools. Fundamentally, this may be accounted for by a long background in teaching telephone craftsmanship, dating back to the early days of the

Bell System Courses for Service Men

Basic Courses	Length of Course in Weeks
Installer—Repairman	6
Switchboard Installer	6
Central Office Repairman	6
Lineman	6
Teletypewriter man	6
Advanced Courses	
Carrier—Repeater man	8
Radiotelegraph man	8
Radio-Telephone man (Tank Corps)	6
Vocational Instructor Training	2
Line Foremen	6
Wire Chiefs	5
Teletypewriter Supervisors	7
Teletypewriter—Staff assistants	12

business. Telephone people all along the line are training-conscious, due, if for no other reason, to the industry's rapid growth and to its many technical developments.

Instructors in Bell System schools are top-grade craftsmen or foremen specially selected for their job knowledge and skill plus the ability to impart this to others. This last element—teaching ability—depends a great deal upon use of sound teaching techniques coupled with the inspirational qualities which motivate the learner, lots of patience, and a sympathetic understanding of human nature. These qualities have been sought out and built up in Bell System instructors and have helped greatly to pave the way for Army or Navy students—particularly for the beginners.

THEIR INSTRUCTORS posed with these Navy men whose course covered the installation and maintenance of teletypewriters

When it comes to skinning and soldering wire, adjusting relays, and tracing circuits for the first time, the beginner is in a new and strange world. His related mental responses too are sometimes slow and faulty. Learning at this stage, as golfers will testify, is largely a matter of habit-formation involving mental processes as well as manual dexterity. These are gained through supervised practice in doing the job the right way at the very beginning and by learning in easy stages, one step at a time. To get this, classes in telephone company schools are kept down to eight or ten men under one instructor. He follows with the service men the same

step-by-step teaching pattern which has long been in use by plant department foremen and supervisors on the day-to-day job. This teaching pattern, incidentally, is now being used by foremen and "lead men" in breaking in new people in many war industries throughout the country. Visual aids in the form of movies and slide films have a place in System training programs, and they are freely used in courses of instruction for service men.

Building up safe working habits is all-important in the Army's dangerous job. In new work situations and strange surroundings, men are prone to accidents and one of the first things the service man has to learn is how to take care of himself and at the same time keep a weather eye out for the safety of his buddies. These things, of course, are all a part of Army indoctrination but they bear reiteration and have always been stressed as "key points" in the telephone companies' schools.

NOT ALL of the Bell System schooling for service men is on a classroom basis. In fact, wherever possible they are sent out with working telephone crews where they can learn the job under field conditions.

Service men in training to serve as linemen and line foremen, for instance, work with regular field construction crews to get practice in digging pole holes, stringing wire, and making emergency storm repairs.

In the case of the line foreman's course, trainees are sometimes grouped to form a practice gang in which each student takes his turn at acting as the gang foreman while the others serve as linemen—all under the direction of a seasoned foreman from one of the regular telephone construction crews.

Service men taking the wire chief's course usually are assigned to accompany a telephone company plant wire chief in rural territory where they can watch the wheels go 'round and learn at first hand about the many details which make up the administrative side of the district plant chief's job.

Among the letters coming back from the boys overseas was this comment from a Signal Corps student: "Yours is one of the best, most efficient and quickest ways of getting over to a soldier the fundamentals of the communication system. This is due to well trained instructors, well planned methods of teaching and the instructors being men of high quality with a background of years of experience in telephone work. As one of the boys in our outfit said, 'When you start you feel as though you were in a dark tunnel but when you finish you feel as if you were a veteran in the business!' "

Life at the Schools

NO REPORT on training activities for service men would be complete without a few sidelights on the students, their background, and their daily life while they were attending telephone company schools. A report from one of the Associated Companies gave this picture:

"Altogether 121 men have completed one or more of our basic courses and they are now back with Army organizations, either instructing others or performing the various duties essential to extending, operating, and maintaining the Army's lines of communication. They came from

32 states and Canada, and their previous jobs include almost every walk of life. Among them are an Indian rancher from Montana, a motion picture casting director from Hollywood, a bartender from Chicago, a sculptor from Ohio, coal miners from West Virginia, a woodsman from Vermont and a steeple jack from Michigan."

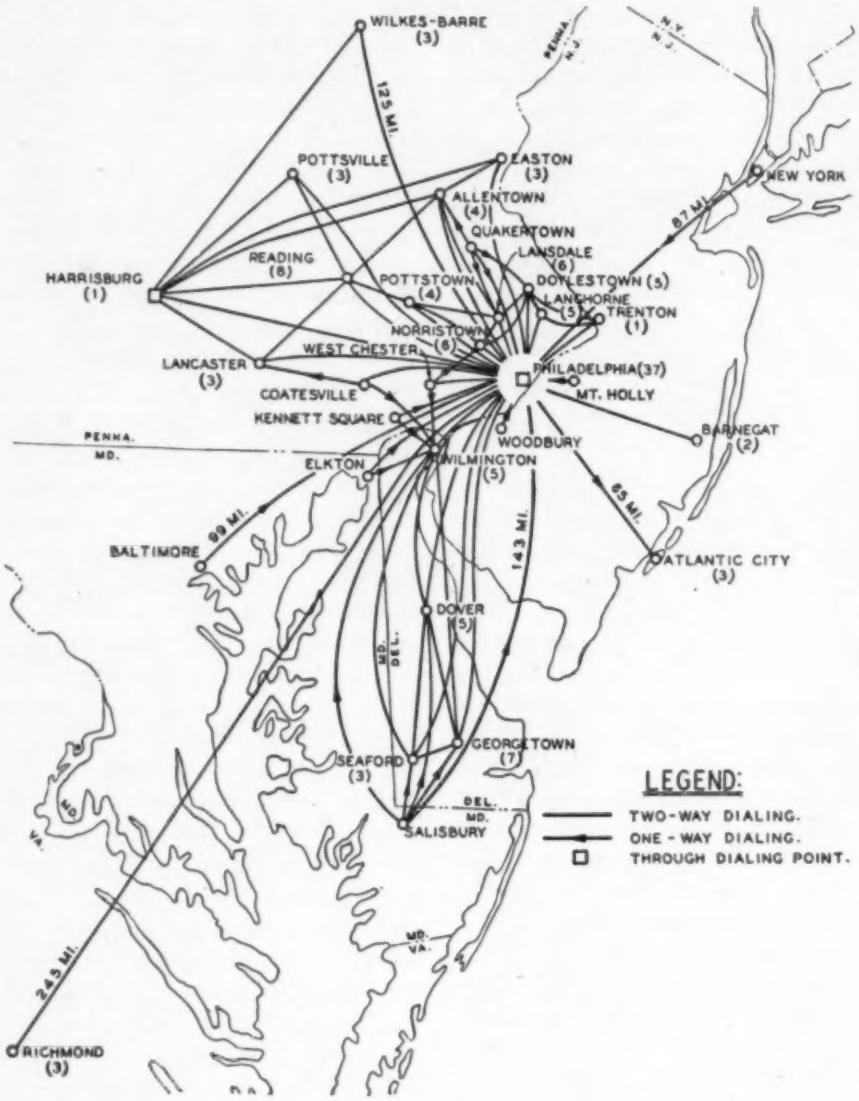
The other students ribbed one lad who had spent all his life on a farm in a remote section of the Dakotas when he told them that he had never even used a telephone during his life back on the farm. To their surprise, he took the telephone training in his stride and on graduation he could put in telephones and clear troubles with the best of them.

Another soldier came in to school bronzed and breezy from cow punching in the Wyoming cattle country. His first try at pole climbing revealed boundless energy untempered with caution. His instructor told him to climb up the pole only a few feet at first until he got the hang of it. Not for him. He stepped right on up the pole before his instructor could stop him. Then, at some distance above the ground his climbers cut out and down he came. Fortunately he landed like a cat on his feet and with a sheepish grin on his face which seemed to say—"This is just another one of those bucking broncos at the rodeo back at Cheyenne." Then with a grim look, he jumped on the pole and before his amazed instructor could stop him, he was grinning down at the rest of the gang from the top of the pole.

MOST OF the boys in basic training were young and inexperienced, but spirited and eager to learn so that they could get over there, beat the Axis, and get home again—just like that. Naïve, too—one wrote back, "I thought when I left your school that I was through with Ohm's law, but I was wrong. The army just loves that guy Ohm!"

For a place for students to live, the Army often arranged board and lodging in the neighborhood of the company school, or at the local YMCA. If military barracks were handy, they stayed there, and marched smartly back and forth to school under the inevitable top sergeant, who maintained discipline and saw that the boys burned their quota of midnight oil.

Nor was life all work and no play, thanks to the friendships which sprang up at telephone company gatherings or on week-end visits of the service men to homes of instructors and other telephone people. Graduation day, ("it came all too soon," they would write back later) was topped off usually with a farwell dinner, presentation of diplomas, and speeches in the usual fashion. After graduation many appreciative letters have filtered back from students from all parts of the world. One wrote this to his instructor: "In regard to your instructions you have done a swell job for us. You may not be in uniform in the Army but your job is just as important as the man behind the guns." His words but echo the statements of high ranking officers, more formally expressed, to the effect that the importance of communication in this war is such that telephone people everywhere are virtually members of the communication branch of the military services.



THIS IS the intertoll dialing network, centering at Philadelphia, which is described in the article beginning on the opposite page. About 1,500 dial intertoll trunks are involved, and over them calls are being completed more swiftly than by previous methods. The numerals in parentheses under the cities indicate the number of tributary exchanges reached at each point for direct dialing

Adaptation of Crossbar Switching to Intertoll Purposes Helps Speed Up Handling of Increased Traffic and Marks a Forward Step in Improvement of Service

A Dial Switching System for Toll Calls

Howard L. Hosford

EVEN FOR THE MOST seasoned of telephone veterans, there is something about a cutover that makes for drama. Always it marks a change from the old to the new; a step in the direction of something better. Before it come long weeks of careful preparation; days and sometimes nights of trying to foresee and guard against the slightest detail that may go wrong. But always, in the most commonplace of cutovers, there are the few moments before the zero hour when everybody, from operators to engineers, silently prays that all will be as it should.

There was such an air of tenseness at Philadelphia on the night of August 21 and the early morning hours of August 22 last. For the cutover that was scheduled for that time and place was no mere episode; it was one of the milestones of telephone history. It marked the introduction into commercial service of a toll crossbar switching system, adapted for intertoll dialing by operators, which had been designed by Bell System engineers as a means of meeting some of the problems arising from the increasing volume of toll calls in recent years. In the few months during which it has been in use, the new system has operated so successfully that it has become apparent that its inauguration was the first step in a development that will have far-reaching results.

The magnitude of the toll plant in most of our larger cities has made it increasingly difficult to furnish to toll operators means of direct access to much of the equipment which they must utilize to complete toll calls. It is evident that future demands for service will be such that conventional switching systems and operating methods must continue to be more complex and therefore less suitable for handling the volumes of traffic,

to say nothing of permitting improvements in the quality of service. To meet this situation, the new system was designed.

Intertoll dialing in itself is not new, for operators in various parts of the country have been completing toll calls for several years by dialing directly. This Toll Switching System is especially significant as it has been designed so as to extend the field of toll dialing by operators to include the largest cities, and joins together various types of dial equipment.

THIS JOINT PROJECT of the Bell Telephone Company of Pennsylvania and the Long Lines Department known as the No. 4 Toll Switching System has been in service in Philadelphia since August 22, 1943. A thorough canvass showed Philadelphia to be an ideal location for the initial installation of the No. 4 Toll Switching System. In addition to a toll traffic increase resulting in a major relief requirement, this area affords an opportunity to link various types of equipment presenting virtually every known toll requirement characteristic.

The intertoll dialing network associated with the Philadelphia project includes many points in an area reaching from Richmond, Va., to New York, and from Harrisburg, Pa., to Atlantic City, N. J. Calls involving other points are handled in the normal manner.

Toll operation in most large offices implies the provision of certain equipment and switchboards for the handling of outward, inward and through traffic and the associated tandem equipment. How this new development affects each of these steps in long distance telephoning can be briefly stated.

In connection with outward toll calls, an operator usually obtains the circuits to be used in completing calls either directly in the multiple at her position or, in the case of some of the larger cities, through an intermediate toll tandem switchboard. The No. 4 Toll Switching System represents an improvement over this switchboard.

Ordinarily, inward calls are handled at switchboard positions where inward operators receive requests from outward operators at distant offices, and either dial or enlist the aid of local operators to complete these requests. Here too the No. 4 Toll Switching System presents an improved method of completing such connections.

Similarly, the specialized functions of the conventional through board are performed to advantage through the medium of the No. 4 Toll Switching System.

Components of the System

FROM A TRAFFIC standpoint, the No. 4 Toll Switching System actually comprises three units—the switching equipment itself, which is wholly mechanical, together with so-called No. 4 and No. 5 switchboards. The No. 4 Board is a cordless, key-type call distributing board which is used in conjunction with the new switching system for such calls as must be given to an operator by offices not equipped for intertoll dialing. The operators at this board function as combined inward, through and tandem operators—thus eliminating the provision of separate units to provide these particular services.

With this information in mind, certain representative phases of the operation of the new system may be somewhat clearer. However, even non-technical descriptions of telephone operating are apt to be misleading to those who are unfamiliar with traffic operation, and it may be well at this stage to draw an analogy between the functions of this system and the local dial central office with which most readers are doubtless familiar.

The outward toll operator in Philadelphia bears the same relationship to the functioning of the No. 4 Toll Switching equipment that the subscriber who has a dial telephone bears to the functioning of the dial equipment in a local central office. The same is true of outward toll operators in those cities which have

OPERATORS AT the No. 4 toll switchboard in Philadelphia handle inward and through calls. The keys which they press set up electrical impulses just as do the dials which subscribers use to make local calls

now been equipped to enable them to dial Philadelphia telephone numbers directly. Part of the time both the No. 4 Toll Switching equipment and the local dial central office equipment function in response to impulses transmitted to it by an individual, while in other cases it is necessary to signal an operator to assist in handling the call.

If you live in Harrisburg—by way of illustration—and wish to call a subscriber who lives in Philadelphia or in Richmond, Va., the Harrisburg toll operator will reach the number in either city by simply performing a few dialing operations which are the virtual equivalent of the steps a subscriber takes when dialing a local number.

On the other hand, at offices which are not equipped to dial into the No. 4 Toll System, it is necessary to reach an operator in Philadelphia in the same manner as was done before the advent of the new system. In completing such a connection, however, the Philadelphia operator does so through the use of equipment in the No. 4 System.

IN THE PROVISION of toll circuits, it is not contemplated that a circuit will always be immediately available for an operator's use. Again, the economics of through switching limit the time a circuit can be held at an intermediate point awaiting completion to another circuit. Thus, in many instances on switched traffic the calling operator is dismissed after having left a request for the desired circuit. This brings us to the No. 5 Board, where traffic of this nature is handled.

In brief, there is no basic difference between the essential operation of the No. 5 Board and the conventional through board where such delayed traffic is handled. However, operators handling calls at this board must make use of the new switching system to obtain both the calling and called offices by dialing. Through the medium of special equipment arrangements, any operator who attempts to obtain circuits through the new switching system on which traffic is subject to a posted delay is automatically routed to the No. 5 Board. Here the delay is quoted to the calling operator. In the case of a call switched at Philadelphia, the No. 5 operator will, in addition, record the request for the desired circuit.

TO HANDLE the traffic routed through the No. 4 and No. 5 Boards, 150 operators, together with the necessary supervisory personnel, were trained by the most up-to-date training methods and at the initial cutover there was a force totaling some 170 people to run the office. Prior to the cutover, the first trainees were given experience by handling some 300,000 test calls of every conceivable traffic characteristic. These were routed through the new system to break in the equipment and shake down potential troubles.

The far flung aspects of the Bell System also made it essential that other toll operators, who might be handling calls to and through Philadelphia, be made familiar with the new practices. As a result of the close coöperation and intelligent coordination of effort on the part of the Bell System personnel at outlying offices with the Philadelphia people, the cutover and operation of the No. 4 System proceeded smoothly.

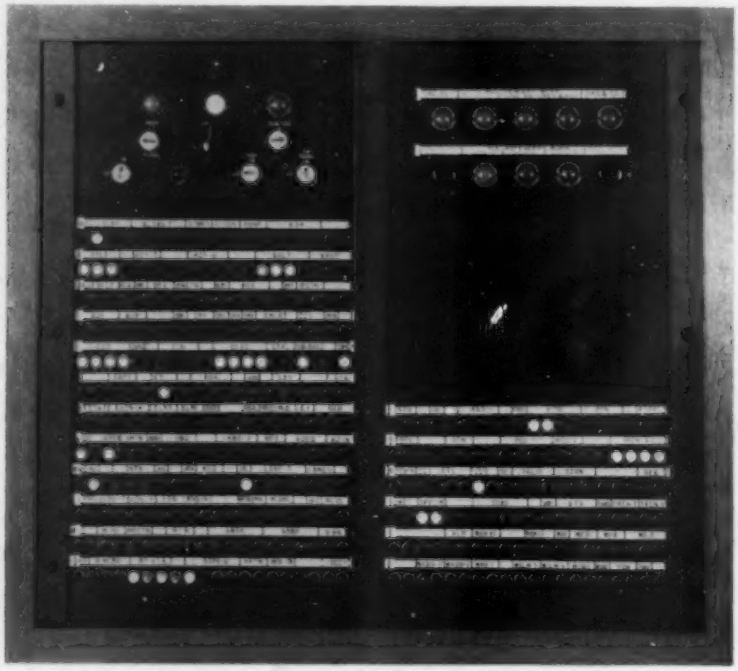
The Cutover—and After

THE MULTITUDE of steps necessary to cut this new system into service were taken during the afternoon and night of Saturday, August 21st. The cutover committee which had spent many months in setting up the detailed plans and the necessary organization to do a workmanlike job had estimated that the new equipment would be ready to put in regular operation on the following Sunday morning at 3:00 A.M. Two weeks prior to cutover, a dress rehearsal was held at which time about ten per cent of the circuits were put through their paces. This preview of the cutover gave assurance that the procedures were satisfactory and permitted the cutover personnel to obtain actual experience. It also showed that the estimates of the time to do the job were about right.

CALLS WHICH could not be completed originally through the No. 4 System because of busy circuits are handled at the No. 5 switchboard

Visitors in the operators' restroom just before the cutover heard a buzz of questions: "How will it work?" "Will I be the one to handle the first call?" "What will the offices working into Philadelphia think about it, and will they know what to do?"

Shortly before the appointed time a group of operators took their positions at the new No. 4 switchboard and anxiously awaited the first incoming call. At precisely 3:00 A.M. it came in and any pre-arranged selection could not have been more appropriate for a system serving a nation-wide toll network. The call spanned the continent from Martinez, Calif., to Germantown, Pa. In accordance with standard routing instructions, the Martinez operator routed this call to San Francisco, then to Pittsburgh, then to Philadelphia —where a No. 4 operator was brought into play. The Philadelphia operator, though visibly excited, performed her duties efficiently and accurately. Thereafter, additional calls began to come through, and in no time every operator had her opportunity to use the new equipment. The No. 4 Toll System was officially launched.



USEFUL IN the day-to-day administration of the office is the quick picture which this control cabinet gives of circuit conditions, stored-up calls awaiting completion, and the equipment situation as regards senders and repeaters

In the day-to-day administration of the office, there are many helpful features, not included in currently conventional toll switchboards, which are a distinct aid to the traffic operating people who are responsible for the maintenance of service. For example, the System automatically routes each incoming call to the next

available idle operator and, if all operators are busy at the moment, waiting calls are stored up and thereafter are handled in their proper order. This contrasts with the conventional toll inward board, where the operator answers signals as she recollects the order of their appearance.

Records and Measurements

TO PROVIDE information of value for future installations, arrangements were made for the liberal provision of registers and meters to measure any and all phases of the various steps performed by the equipment. Some 600 registers and meters were provided. These aids are not entirely new to telephone work but their application to toll inward and through service is a departure.

As a further aid to the maintenance of a satisfactory service level, the No. 4 Board is equipped with colored lamp signals to indicate the volume of stored-up calls awaiting completion. In addition, a continuous pen register record of this information is kept on a 24-hour basis. These features permit a better administration of the office than is possible with the older types of toll equipment.

The load imposed upon various parts of the equipment must be balanced and carefully controlled, in order to expedite the routing of calls through the new facilities. This balance is achieved by an analysis of register readings. In addition, ammeter readings may be taken to check the load at any given time.

Is the No. 4 System "earning its keep?" Day in and day out it is running satisfactorily and both the equipment and the operators who use it deliver a high grade of service. Daily some 80,000 tandem, inward and through connections formerly handled by operators are routed through the equipment.

What do the operators think of it? Whether in the No. 4 Toll office and in other Philadelphia offices, or in the many cities which originate toll calls to or through Philadelphia, all indications are that they like it, and look toward the day of more installations of this type.

THIS CONTINUOUS RECORD of the volume of stored-up calls is an important aid to the maintenance of satisfactory force adjustment

PERHAPS IT IS fortunate that the Philadelphia System was placed in

service under conditions of wartime overloads on our toll plant. This is a severe test, and it is clear from the results being obtained that the No. 4 layout is equal to the situation.

However, in the use of intertoll dialing systems, there are certain advantages and economies which cannot be fully realized until such time as offices are not operating under conditions of wartime overloads. In connection with post-war planning, studies are now being made to determine future installations in order to take advantage of the possibilities of the new system. It is confidently expected that this will provide faster service on outward, inward and through calls, and that transmission will be improved. These advances should result in overall economies in outside plant and operating. Thus, the Philadelphia installation providing for toll line dialing by operators may well be regarded as a definite contribution to a program designed to lead ultimately to toll line dialing by customers.

The "Affiliated Plan" Is Ended

OPERATION OF the "affiliated plan" for appointment of Bell System men to designated cadres of the Signal Corps has been terminated. Readers of "Skilled Manpower for the Signal Corps" in last September's issue of this MAGAZINE, which described how the plan functioned, may be interested in the following letter to the A. T. & T. Company from Major General H. C. Ingles, Chief Signal Officer, U. S. Army:

"The Signal Corps program for procurement of military personnel by direct appointment of civilian employees from the organizations sponsoring the affiliated units, in which your organization wholeheartedly participated during the past several years, is being brought to a conclusion. The achievements of the men and the units in the service of our country will be forever inscribed in the annals of the Signal Corps. I wish to extend my appreciation to both the officers and employees of your organization who so unhesitatingly devoted their time and efforts in making the plan a success."

To General Ingles, A. T. & T. Vice President Keith S. McHugh replied as follows:

"It was good to hear from your letter . . . that the achievements of the men and the units in the Signal Corps under the affiliated plan have been so satisfactory in the service of our country. I am sure that all Bell System people take pride in the fact that our men who entered the service under this plan had the experience and training which has proven of value to the Army and to the country in this emergency. In acknowledging your decision that the operation of the affiliated plan is being brought to a conclusion, I should like to express our appreciation of the cooperation of and pleasant associations with your organization."

Carrier and Other Toll Equipment, Assembled in Compact Units, Provides the Means for Fixed Communications for the Armed Forces behind the Battle Areas

"Packaged Carrier" for the Signal Corps

Ernest W. Baker

THIS WAR has been referred to by someone as an "Engineer's War." With the marked trend toward mechanization and a war of rapid movement, the skill of the engineer is urgently needed in nearly all branches of the armed forces. This is particularly true in the field of communications. The faster the war moves and the more complex it becomes, the more vital is the need for adequate communications. The importance of reliable and speedy interchange of information is obvious in carrying out a combined land, sea and air operation such as the invasion of Europe.

Broadly speaking, communications systems of the Army are of two types—mobile and fixed. In the actual battle areas, mobility is essential for continuous communication between all the fighting units. Farther back, between headquarters of the larger army units and, in fact, clear back to Washington, there is need for fixed communications.

The Plant Engineering Agency of the U. S. Army Signal Corps, located in Philadelphia, is responsible for the engineering of fixed wire and radio communications for the Army in all parts of the world. This plant, in many respects, is like Bell System toll plant and its design involves similar problems. Therefore, as might be expected, Col. Will V. Parker's staff of officers and civilians responsible for design consult frequently with Bell System engineers in the solution of unusual problems that arise. During one of those discussions the Army suggested the further development of the idea of "packaging" which had been employed previously in the Bell System for certain types of equipment.* This involved extension of the packaging

* See "War Emergency Stocks in the Bell System," MAGAZINE, September, 1943.

plan so that the equipment for a complete communications network could be set up in this manner.

The Need for Packaged Equipment

THE COMMUNICATIONS layout along the new Alaska Highway is an example of the type of project engineered by the Plant Engineering Agency. From consultations on this and several other similar projects, it became evident that the work could be done quicker if it were not necessary to consider each job on a "tailor-made" basis. The Signal Corps seemed to need a set of "building blocks" which could be put together quickly to produce a complete communications layout. They wanted to be able, for example, to order a carrier system in advance of specific need in much the same way as they might order shovels, guns, trucks, etc. With such a scheme the detailed engineering and ordering could be much simpler and, in fact, it seemed that all the moves, from the time a project is conceived until it goes into service, would require less effort if it were done on this basis.

In using the equipment to meet the Army's needs, certain of the small building blocks are always associated with each other so the logical thing to do was to put them all together in the same container—a "package" of such small building blocks. Then the package unit itself could be used as a bigger building block. That is exactly what the packaged equipment is; each package is an assembly of small units of apparatus normally associated together in furnishing toll circuits.

After some work to decide what pieces of equipment to put in each package, the Signal Corps placed orders for the equipment and the Bell Telephone Laboratories went ahead with active development of the desired arrangements. Three-channel open wire carrier systems (Type C), telephone repeaters, and signaling apparatus were the first items undertaken. There were conferences from time to time with the Army people as the work progressed, to review the designs, perhaps to change things a bit in order to take care of a new problem the Signal Corps may have encountered in some war zone. Also, other items of equipment were added to the development program in an effort to provide a packaged arrangement for each of the units required to put together a complete telephone and telegraph communications system.

Design Objectives

THE AIM HAS been to design and make equipment which would satisfactorily meet the needs of the Signal Corps for fixed wire communications in the various military theaters in all parts of the world, with a minimum of specific project engineering, installation, and maintenance effort.

The first requirement was speed. During a recent address in New York, Brig. General Frank E. Stoner described three "bests" that might be desirable for a particular job:

1. Scientific best—which comes closest to perfection but takes longest to produce.
2. Engineering best—a slightly less faultless job requiring somewhat less time.

3. Best that's available—This, General Stoner said, is the "best" that the Army frequently has to use because it is needed right away.

In the case of package systems, time was a controlling factor, so the initial designs employed units of standard Bell System apparatus wherever practicable. The compact equipment assemblies were quite different, however, from existing arrangements of System equipment for central office installation. These first designs were then followed by improved ones to make the equipment moisture resistant and otherwise suitable for use under a wide variety of climatic conditions.

Ruggedness was one requirement. Under war conditions, the equipment must stand up under rough treatment. Also, equipment packed for export must be protected during transit against the effects of tropical rains, high humidity, and extreme temperature ranges.

The size and weight were limited so that the individual packages could readily be moved. Though the apparatus is intended for fixed communications, a considerable amount of handling may be necessary, often under difficult conditions, before the location of the equipment becomes "fixed."

Another important consideration was flexibility. The major items of apparatus selected for the several assemblies were chosen for the kind of wire and pole lines most likely to

SIGNAL CORPS OFFICERS inspect cases of packaged equipment which have been delivered for an Army field trial. They represent a typical shipment of equipment for one communications office

be employed, but something had to be done to take care of the unusual cases.

In war the unusual cases are common. Where this equipment is to be used, there will not always be a supply depot or a hardware store close by, so it was important to put into the packages all the apparatus required to establish communications quickly wherever they are needed. Of course, this did not mean putting two of everything in the package as Noah did in the ark—the package couldn't be made that large and there was a shortage of critical materials. What it did mean was that the Laboratories had to design a number of special pieces of apparatus so that one unit, with simple adjustments, could do the job of several pieces. For example, a piece of equipment designed to be used with copper wire could also be used with copper-steel wire. In this way the packages were made readily adaptable for use with a wide variety of types of line facilities. This feature should be very helpful in making extensive use of existing communications plant in occupied territory.

The Various Packages

QUICK INSTALLATION was a controlling design requirement. In general, each box of equipment is arranged so that it may be put into service in a short time by plugging into a primary source of a-c power and making relatively few line-up tests. Storage batteries are not used. The installation and line-up procedures are outlined step-by-step in the proper sequence in special instruction pamphlets shipped inside the box with the equipment to which they apply.

The development project included complete equipment for telephone and telegraph circuits. As a typical example, suppose our army arriving in Italy found a telephone line several hundred miles long and carrying two pairs of wire, perhaps with the wire missing here and there in several spans. By patching up the missing links of wire and using the package equipment, six telephone and 28 telegraph circuits could quickly be set up for the entire distance; or they could be cut into pieces and used for a still greater number of shorter circuits to intermediate points.

The circuits and apparatus employed in this equipment have been made more highly moisture resistant than is required for corresponding Bell System types, and will stand up over a wider range of temperature. The number of types to be considered in ordering has been minimized by supplying a small amount of extra apparatus in each package for making simple modifications in the field to care for a variety of plant conditions. The equipment can be ordered and manufactured in bulk, shipped in bulk to a theater of operations, and there assigned to fit the requirements then existing. A typical unit of packaged equipment, the Type C carrier terminal, is shown in the photograph on page 243. This unit takes three separate telephone conversations and bundles them together for transmission over the wires. A similar unit sorts them out again at the far end.

Carrier Telephone Epuipment

ON A PAIR of open wires it is customary to transmit one two-way conversation at voice frequencies: that is,

the speech sounds are converted into electrical impulses in the telephone set and are sent over the toll circuit at these so-called "voice frequencies." One or more additional two-way conversations can be handled over the same pair of wires by employing the carrier technique. With this means "demodulated" to the original voice frequencies.

Naturally, the Signal Corps wanted packages of carrier equipment because fewer shiploads of wire will be required than would be needed if carrier were not used. Two types of carrier equipment are being used, the

SIGNAL CORPS MEN are removing the packing case from one unit such as is shown on page 243 before up-ending it onto the base which has been prepared at the left to receive it

the voice frequencies of the separate conversations are changed or "modulated," to use a technical term, by different amounts, so that in effect they are piled on top of each other for transmission over the toll circuit. At the distant end filters are used to sort out the separate conversations and they are changed back again, or first providing one circuit and another providing three circuits (Type C). By using repeaters every 100 to 150 miles, the length of these latter circuits can be extended to great distances.

The Type C carrier system involves separate packages for an East terminal, a West terminal, a repeater and

a test package. The equipment will be mounted in cabinets seven feet high. Spare vacuum tubes, wire, tools, concise installation and operating instructions, drawings and miscellaneous items are all included.

Carrier Telegraph Equipment

THIS PACKAGE includes equipment which may be used to slice one telephone circuit into 12 pieces, each piece suitable for handling a telegraph message. Thus, a Type C carrier telephone system plus this package could be used to furnish two carrier telephone circuits and 12 carrier telegraph circuits—in addition to the voice frequency circuit—all on one pair of wires.

The operation of this carrier telegraph equipment, as it is called, is similar to that of the standard Bell System 12-channel V.F. carrier telegraph system. For flexibility, however, instead of a 12-channel system there are two parts to the Signal Corps arrangement. The first part includes channels one to six and the second part includes channels seven to 12. They can be used independently as six-channel systems, or together to constitute a 12-channel system.

Voice Frequency Telephone Repeaters

THE LATEST TYPE of standard Bell System telephone repeater has been adapted to Signal Corps use. One piece of apparatus, a universal line-balancing network, included in the same package with the repeaters, can be adjusted in the field so that the repeater may be used with any type of open-wire or cable likely to be placed by the Army or found in occupied territory.

Two types of repeater packages have been made available. The first contains three repeaters. It also includes a bridging circuit which provides for talking at an intermediate repeater location. The second is a single repeater unit which has been made as complete as possible—including a ringer—for use at isolated points where only one repeater is needed.

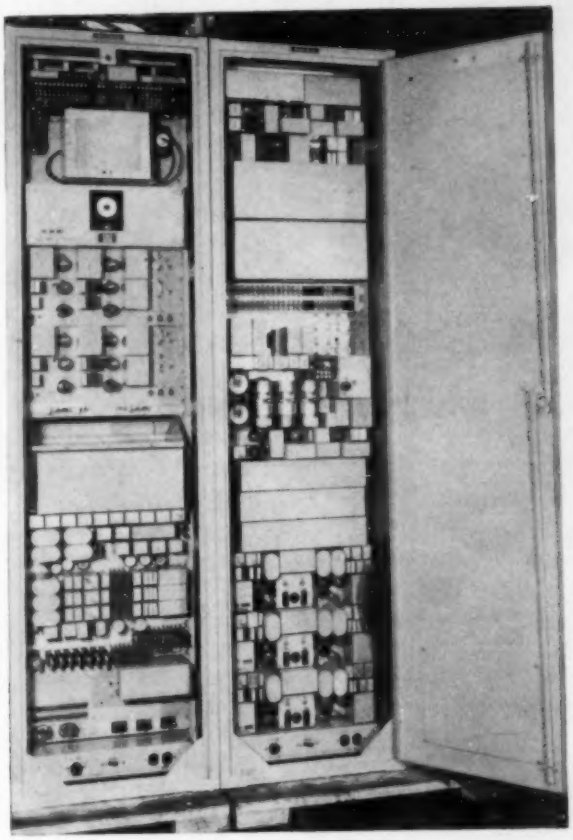
Other packages include voice frequency ringers to signal over the toll circuits, telegraph apparatus for circuits where use of the carrier telegraph is not desirable, testboards and testing equipment—in short, all the equipment the telephone man needs in order to build a high grade toll plant.

The packaged equipment, except the testboard and the testing equipment, is mounted in steel cabinets with doors front and back and panels mounted on a vertical rack approximately in the middle of the cabinet. The cabinets are made 7′, 3′–6″, and 2′–4″ high to line up in rows 7′ high. The largest cabinet fully equipped weighs about 600 pounds. There would be no trouble at all finding space for a few such cabinets somewhere in Berlin or in the Imperial Palace in Tokyo.

Field Trial

BELL SYSTEM practice is to subject a new development to a thorough field trial before introducing it into the plant. Such a trial under expected operating conditions usually discloses any undesirable features and some-

times indicates certain changes in the design. In the case of these package systems for the Signal Corps, there were obvious difficulties in attempting to conduct such a trial in an actual theater of war. But, despite the fact that urgent need required that the first few systems be shipped to war zones as soon as they could be produced, it did not seem wise to forego a trial entirely. The equipment might be sent to any part of the world and a considerable time might elapse before comments concerning operation would get back to the Laboratories from Army people using the systems in distant countries. Accordingly, a field trial was made in the Long Lines plant under more or less simulated war conditions. For instance, a line was purposely chosen which had not previously been arranged in all sections for three-channel carrier operation. The equipment was installed



PACKAGED "Type C" terminal and associated line and power bay. Together they provide three additional telephone circuits on a pair of wires which could otherwise furnish only one

and put into operation by Signal Corps personnel and subjected to expected operating conditions by using it in connection with various assigned war problems. The trial included tests and observations by Bell System engineers but an effort was made to approach as closely as practicable some of the conditions that may be encountered in actual use for military purposes.

THE EXPECTED EXTENT of use is perhaps a good indication of the importance the Signal Corps attaches to the package project. Just how much equipment of this type has been ordered cannot be disclosed. Some idea of the magnitude of the job can be given, however, by saying that the carrier telephone equipment contemplated could provide nearly as many circuit miles of Type C carrier as were in operation in the Bell System plant when we entered the war, about 23 years after carrier was first used. Proportionate quantities of the other items of packaged equipment are expected to be used. The Plant Engineering Agency of the Signal Corps has estimated that use of the equipment for military wire systems will save more than a million pounds of copper. Initial deliveries were made in June and the Western Electric Company is now producing the equipment at an increasing rate.

As is the case with many war developments, some of the principles involved in the package project will find useful application in the peacetime communications plant.

THE RADIO TELEPHONE SYSTEM which for the past three years has connected the Island of Santa Catalina with the rest of the Bell Telephone System was closed down on August first. An enlarged service to the Island is now being given over two submarine telephone cables, which were laid to the Island a few weeks before the closing of the radio.

The passing of this radio system is of more than usual interest, both from an historical and a technical standpoint. It was the first, and so far as known, the only radio telephone system which has ever given a commercial telephone service, meeting in both transmission and signaling (although not as regards secrecy or economy) the ordinary requirements of wire telephone circuits.

The system was originally installed because, under the conditions at that time, it was the only form of communication which could be established to the Island without considerable delay. Its three years of reliable service, combined with the large volume of traffic handled over it, are an ample demonstration of the success with which the system met the requirements of commercial operation.

From the BELL TELEPHONE QUARTERLY, *October, 1923.*

The Public and the Telephone Companies Co-operate in Meeting the Demands of War that Telephone Information Service Be Limited to Essential Calls

Information About "Information"

Howard F. Parker

IN THE ERA now known as "Before Pearl Harbor," thirty-three out of every one thousand telephone calls made were for Information. Now this statement, in itself, does not seem impressive. But in terms of *all* the telephone calls made each day from Bell System telephones in the United States, three and one quarter million were for Information; and to furnish the desired service on all these calls required a daily force of about eleven thousand telephone employees.

Were all of these three and one quarter million Information calls necessary calls? That is, was each Information call a call for a telephone number that could not be found in the telephone directory, such as the number of a recently installed telephone? Unfortunately the answer is "No." Well over one half of the total, or some two million Information calls were "unnecessary," since they were for numbers correctly listed in the current telephone directories. These "unnecessary" calls required many pairs of copper wires to connect them to Information and many operators at Information to look up and furnish the telephone numbers.

Suddenly the nation was hurled out of the "Before Pearl Harbor" state of mind and into war. Just as suddenly, it became essential that every individual's time and service (telephone operators included) be devoted exclusively to one purpose, that of furthering, in every way possible, the vital war effort. Obviously, one immediate step the telephone companies could and did take was to inform telephone users that one of the American ways of doing things in war times was to use the telephone directory first and to call Information only when necessary.

By thus eliminating most, if not all, of the two million needless calls a day to Information, three important

contributions to the war effort would be achieved. First, several thousand employees could be transferred to essential work, such as handling vital long distance calls to and from the military, the government and other essential customers. Second, many thousands of miles of copper wire used to connect these non-essential calls through to Information could be released for use on vital war calls. Third, it would not be necessary to provide additional Information desk positions, involving new critical materials such as copper, lead, tin, etc., and the additional thousands of miles of copper wire to connect still more calls to Information as the number of telephones increased rapidly under war time requirements.

Seeking Public Coöperation

THE STEPS taken by the telephone companies to obtain the coöperation of the public are probably familiar to everyone. For one thing, there have been the many advertisements placed in newspapers, periodicals, etc., all with bold-faced headlines, such as "Needless Calls to Information Slow Up War Time Telephone Service"—"Why Make Two Calls When One Will Do?"—"Please Do NOT Ask Information to Look Up Numbers That *Are* Listed in the Directory" and many others.

Another step is to have the Information operators indicate on these needless calls that the number wanted *is* in the telephone directory. For example, you may have heard an Information operator say in response to your call "That number is listed in your directory as Main 1234," or "That number is listed in your directory. Will you look for it there the next time please? The number is Main 1234," or perhaps the more positive phrase "That number is listed in your directory. Will you look there for it please?" In the last case, the operator does not give the number to the customer unless he indicates that he has looked in the directory and is unable to find the number, or that for some other sufficient reason he is unable to obtain the number himself.

All of this discussion, down to this point, indicates that there is a very definite job that every telephone user can do to help the war effort, by using his telephone directory *first* on every call and calling Information only after he has done so and has been unable to find the number. Even when the calling customer knows that the party he wishes to talk with has moved to another address in the same city, he does not need to call Information, as in many cases the party still has the same number. If the number has been changed and the old number is called or dialed, an operator (not Information) will intercept the call and give him the new number. If the number has not been changed, a call is saved, and the telephone company is aided in doing its job of getting the vital war telephone calls through on time.

WHAT HAS BEEN the result so far? How well have the telephone users coöperated in this part of helping the war effort? The results to date have been fine. As with almost everything in life, however, there is room for further improvement. A few figures that show the present results may indicate the extent to which they

can be further improved. In the interval since Pearl Harbor, the number of telephones in the United States has increased substantially. If Information calls from these new telephones had been at the same rate as from the old telephones, there would now be about three and three-quarter million calls per day to Information. Actually, however, such calls now number only about two and three-quarter million calls per day. This means that about one million Information calls per day have been "saved," most of these being of the unnecessary type. The net result has been a reduction of one-half million calls per day below the pre-Pearl Harbor rate and this has made it possible for the telephone companies to divert to vital war traffic some two thousand employees, about ten thousand miles of copper wire, etc., that otherwise would have been needed to handle these half million calls. However, nearly one and one-half million unnecessary calls per day are still being made. The battle is far from being won and everyone can still help, and help more.

AN EXAMPLE of a modern type of No. 1 Information Desk, equipped with team-work circuits. This type of desk normally provides an average-size team of 12 operators

With the telephone users doing their part so well in putting labor and materials to work for essential war purposes, it is pertinent to ask whether the telephone company's Information equipment is such that the *necessary* Information calls can be handled with a minimum amount

of labor and materials. In other words, how well is the telephone company doing its part? That is a difficult question to answer in anything like precise terms. To quote from a previously published article,* "From its early beginnings, the provision of Information service has been the subject of the study and development which are characteristic of the Bell System's approach to the task of rendering a pleasing and efficient service to its customers. Staff Engineers . . . have constantly under review the various phases of this important specialized service—the training of Information operators, the design of equipment, the adequacy of records and other aspects of the job." The broad implications of this quotation form the basis for the statement that it seems entirely reasonable to put the telephone company's score up fairly close to the top figure.

Beginnings of the Service

IT IS DIFFICULT to say just when Information service, as such, first started. While telephone directories have been published since 1878, the earliest of these were simply lists by name of the subscribers to telephone service. No numbers were used and every operator had to know the name of each subscriber in the office and just where on the switchboard "Mr. Brown's line" or "Mrs. Smith's line" was to be found.

An interesting explanation of the genesis of the use of telephone numbers was given in 1903 by the late C. J. H. Woodbury, at that time an assistant engineer of the American Telephone and Telegraph. Said he:

"When telephone central stations were first established, the names and positions on the switchboard of the subscribers were known to operators with strong memories; an epidemic of measles occurred in Lowell, Mass., and Dr. Moses Greeley Parker, a member of the Board of Directors of the telephone company, viewed with alarm, from his standpoint as a physician, the possible condition of affairs if more than two of the four operators should be taken with the measles, and proposed that the subscribers be numbered.

"His associates demurred, as they were of the opinion that the subscribers would give up their telephones sooner than submit to the indignity of being known by number, but in view of the contingency they finally yielded, and to the surprise of all, the new arrangement was cheerfully accepted by the subscribers, who appreciated the improvement in service which resulted from the change."

IN MANY of the cities, especially the smaller ones, it was not until late in the last century that the use of numbers for designating subscriber lines became common and printed directories showing these numbers were necessary. At that time, with all regular calls placed by number, it was relatively easy for the operators to remember the name and number of new customers and therefore each operator became her own Information operator. Very early in the present century, however, a few offices became so large that it was necessary to have a separate table or desk where one or two operators

* See "Providing the Information Service," MAGAZINE, August, 1941.

could concentrate on giving out new and changed numbers from various forms of "improvised" records, frequently written out in longhand or perhaps typewritten.

With the rapid expansion of telephone service in the decade prior to the first World War, this form of Information service was quickly outmoded for the larger cities. These had grown to the point where several central offices were required in each city. Each office had its own small Information desk of usually one to three or four positions. The inadequacy and inefficiency of this arrangement to meet changing conditions led to the idea of centralizing the Information service for all the offices of a city at one desk. The number of pairs of copper wires to be carried from each particular office to the centralized desk would equal the expected number of simultaneous calls to Information from that office. Telephonically, each pair of copper wires would be known as an Information trunk. The answering end of these trunks would be so arranged that any one of several operators could answer any call.

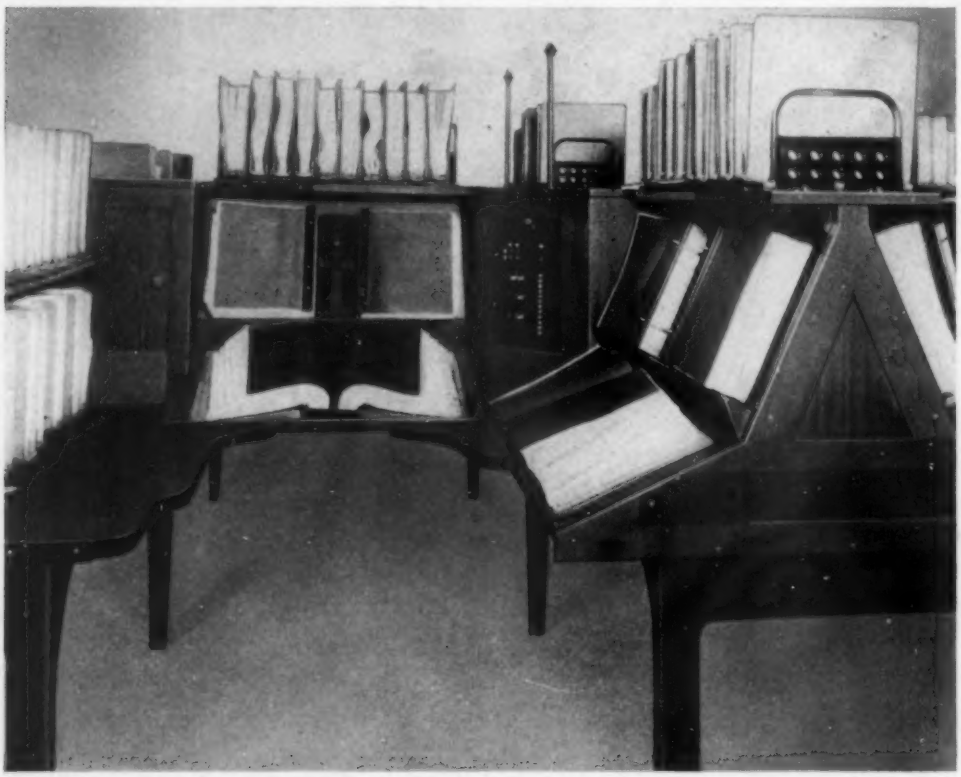
HERE IS an installation of the No. 3 Information Desk with positions for about 120 operators and a team size of about 40

The first centralized desk was installed in 1910 and was known as the No. 1 type of Information desk. It was designed to accommodate book type records * and to provide for a

* For a description of these and other records referred to herein, see "Providing the Information Service," MAGAZINE, August, 1941.

maximum of thirty Information trunks in front of an operator. These thirty trunks were multipled before as many operators as were required to handle the simultaneous calls that would normally be connected to these trunks. It was at this point that Information service really began to warrant "study and development" with staff engineers having "constantly under review" its various phases. It is of interest to note that the major considerations in designing the first centralized desk were basically the same as they are today, although the state of the art in those days did not permit as close an attainment of the goal as is now possible.

Among the principal objectives, two may be cited to illustrate the approach to the problem. One was that the desk should be specially designed to make it possible for the operators easily and quickly to reach the most up-to-date form of ready reference records that could be adapted to Information service needs. A second had to do with making the "speed of answer" by the Informa-



THIS CLOSE-UP of an Information position illustrates desk design to make voluminous records, such as those for a metropolitan area, readily available to the operator

tion operator reasonably fast. This "speed of answer" is the interval between the time a call is connected to the Information desk and the time that an operator is able to answer it. A primary purpose of both of these objectives was to provide better service for the customer; and the first general information on the centralized desk sent to the Bell System Companies by the staff engineers stated, "With the new equipment the Information service will be improved."

The speed of answer is largely dependent upon the number of operators who can actually answer a call that has been connected to a particular trunk. This number of operators is known as the operator "team" size. To illustrate:—with the best records available in those days, the Information operator required about one minute on the average to look up the desired number and give it to the customer. If, at a decentralized desk, there were only one operator and she were busy on one call when a new call arrived, it might mean a delay of as much as a full minute before she could answer this second call, perhaps even more if she had to

THIS IS the No. 4 Information Desk, designed for rotary files

choose between two or three waiting calls. If there were a team of two operators at the decentralized desk, it would mean that every half minute, on the average, one of them would become available to take another call and thus waiting time for an answer by Information would be reduced accordingly.

WHAT HAPPENED TO the team size when a centralized desk was used and what effect did this have on speed of answer? The early No. 1 desks, with a total of about thirty Information trunks in front of each operator, could ordinarily have these trunks multipled before a total of about eight operators. So the team size became eight instead of one or two. With each call taking about one minute of the operator's time, some one of the eight operators would become available for a new call about every seven to eight seconds, instead of thirty to sixty seconds.

The point may be raised that, with thirty trunks and the average call requiring about sixty seconds, the team size should be much larger than eight and the speed even faster than seven seconds. This would be correct *if* Information calls were evenly spaced just so many seconds apart by the customers who make them. But they don't come that way. They come in to the operators in a sort of random distribution.

For example, when one person decides to call Information, he may be the only one in that city who wants Information at that instant. On the other hand, perhaps five or ten or even twenty other people want Information at that same instant. The result is that during certain minutes of an hour there is a tendency for the number of calls to Information to pile up and be higher than the average and substantially higher than in the low minutes of that same hour. Consequently, thirty trunks were necessary just to avoid delays during these momentarily high peaks, but at other times in the hour, less than thirty trunks would have been adequate. Likewise, the operators had to have some spare time included in their total work time, if enough operators were to be available in the peaks to avoid some excessively slow answers.

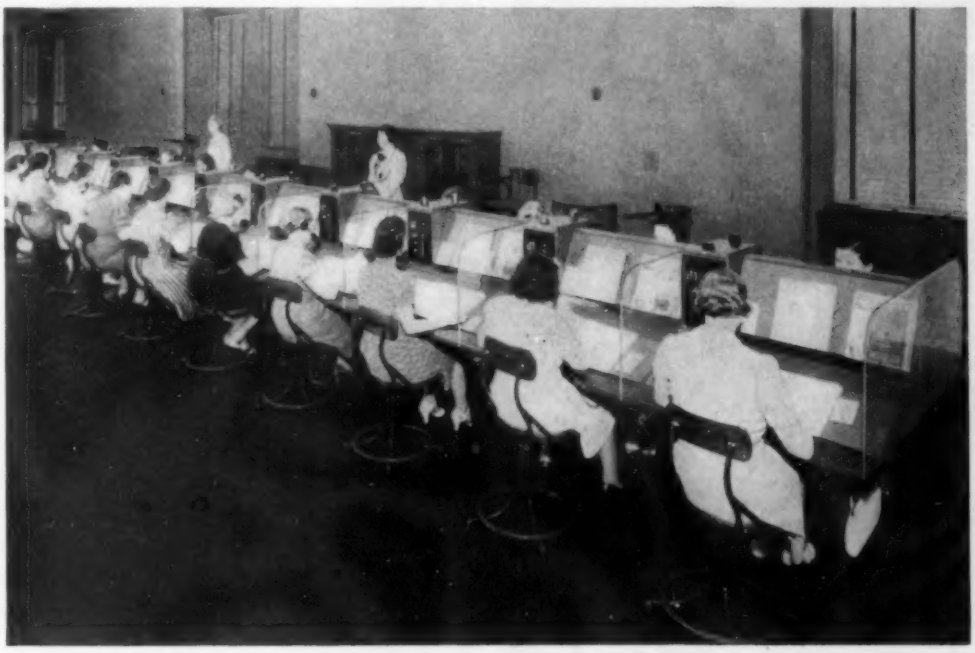
Improving the Equipment

AS A RESULT of increased experience in the giving of Information service, numerous improvements in the No. 1 type desk and its arrangements were made. The first was to increase still further the size of the team of operators. It soon developed that each operator should have a chance at more than thirty trunks, if fast and efficient service was to be given. It had already been necessary to rearrange the equipment from a desk with one team of operators serving thirty or less trunks to a desk with two or more teams of operators, each with up to thirty trunks. However, when all operators in one team were busy, there was no way that a momentarily idle operator in another team could take one of the calls waiting for an operator in the first team. To meet this difficulty, a set of teamwork circuits was provided between each two operators in such a manner that one operator who had at the moment no waiting signal at her position could take up a signal that she could see waiting on the adjacent

position. The effect was to increase the team size by about fifty per cent or from a normal team of say eight to a team of twelve operators, with some one of the twelve operators becoming available to answer a new call about every five seconds.

A second improvement had to do with the condition where all the operators in a team were busy and several calls were waiting to be answered. In order that the operators could recognize and answer first the calls which had been waiting longest, it was arranged for each call signal to change from a steady lamp to a flashing lamp at the end of a few seconds. A third improvement was to provide a sloping surface for the space where the books lie open as the operator looks for a number, in order to reduce eye strain and, therefore, make it easier to read the records. A fourth improvement consisted of enlarging the space for records to accommodate larger sized books of a more modern type.

In the middle nineteen twenties a new form of record known as a "rotary file" became commercially available. Due to limited capacity, it was adaptable, in general, only to the smaller and medium sized cities. The advantage of the rotary file was that operators could find a desired number somewhat faster than in the type of book records then available. A rotary file consists of a stand on



THE No. 6 Information Desk, developed for use in medium-size cities

6 to 4
that number's in the directory!
Please look before you ask "Information"!
WHY MAKE TWO CALLS WHEN ONE WILL DO?
Needless calls to "Information" slow up war-time telephone service!
Please do not ask our Information operators to look up numbers that are listed in the directory
Make Every Call Count
YOU CAN HELP
to speed this
vital war-time service
DETOUR
61,000 DETOURS A DAY
Please keep on helping to reduce unnecessary calls to "Information"
(and thanks for all you've done so far)

HERE ARE some examples of newspaper advertising used to request customers to call Information only when necessary—as discussed on page 246

which one or two rotating racks are mounted. Fastened to these racks are frames which carry a large number of narrow card inserts. Each insert has printed on it the name, address and telephone number of one subscriber. While rotary files could be and were placed on existing No. 1 desks, the structure of this desk was not well adapted for this record. Consequently, a new No. 2 Information desk was designed with adequate space for these new files and to include also the principal features and improvements of the No. 1 desk.

At Nos. 1 and 2 desks, the operators, in answering an information call, must first see a lighted lamp indicating a waiting call and must then operate a key associated with the lamp signal. A lamp and a key together constitute an Information trunk at the operator's position. At these desks, because of this lamp and key arrangement, no very large number of trunks is provided in front of each operator and the size of the operator team is limited to a maximum of about twelve. By the middle nineteen twenties, however, the amount of Information service required by telephone users had grown to the point where many of these centralized desks needed thirty, forty, fifty or even more operators at one time. This required, in effect, several teams of about twelve operators each, in one centralized location.

Other Types of Desks

MANY ADVANCES in the telephone art had, by now, come into being. Among these was the dial telephone and its associated electrical switching apparatus. The staff engineers' knowledge of this new form of apparatus enabled them to apply certain features of it to a new type of Information desk.

This desk provided for automatic distribution of calls to a relatively large team of operators, who could answer these calls in the order or sequence in which the calls were made. Under this scheme, each Information trunk, instead of being wired directly to a signal at an operator's position, is connected to a position selecting switch. This switch automatically associates the call on that trunk with the next operator who becomes available to receive a new call. There may be as many as forty operators in the team from which this one operator is selected. This operator hears a tone signal in her telephone receiver which tells her that she has a call to be answered and she is then in immediate communication with the calling party.

The first desk of this type, the No. 3 Information desk, designed to accommodate book type records and to meet the needs of the largest cities, was installed in 1929. In order that the call distributing, sequence answering, and large team size features might also be available for use in medium sized and smaller cities as well, two other desks were designed. A No. 4 desk similar to the No. 2 in appearance and arranged for rotary files was the first of these. This was followed by the No. 6 desk, arranged like the No. 3 for book records but smaller in over-all size and floor space needs, since medium sized cities do not require the many and voluminous records which the few very large cities must have.

In addition to increasing the team size to forty at the Nos. 3, 4 and 6 desks, there have been many improvements in equipment, in the records of subscribers' names, addresses and telephone numbers and in the operating practices by which the operators use the equipment and records. These improvements have made it possible for an operator to furnish the desired number now in about one-half minute instead of the original one minute. Therefore, with the present team of forty, some one of the forty operators becomes available to answer a new call each second or less. While some spare time must still be included in the operator's work time, to allow for the momentary high peaks of calls, the amount of this margin is correspondingly less than in the early days. Consequently the increase in team size has been important in improving service (fast speed of answer and speedy search of records for desired number) and increasing the efficiency of the operators.

Measuring the Savings

NOW TO COME BACK to the question of how well the telephone company has done its part in this battle to save all non-essential labor and material and divert it to essential war usage. Data are lacking to show the cumulative effect of all the improvements since the 1910 period. However, at the time of Pearl Harbor, the Bell System was using about 5,000 desk and switchboard positions to furnish Information service. These positions required a staff of more than 11,000 employees and something over 65,000 miles of copper wire for the Information trunks needed to connect the then 3,250,000 calls per day to Information. Assuming that no improvements had taken place since about 1925, the effect would have been to increase the 5,000 positions to about 6,000, the 11,000 employees to some 14,000 and the 65,000 miles of copper wire to about 100,000 miles. All this for the then 3,250,000 calls per day. Had the telephone users not responded to the wartime plea to avoid unnecessary calls and the potential 3,750,000 per day figure for the present time been realized, the requirements would, of course, have been more.

THE HISTORY of telephone Information service, like that of the general telephone service which the public knows so well, is one of progressive changes and improvements from the beginning down to the present time. These changes and improvements, in addition to providing vastly better service to telephone users, have contributed materially to the efficient use of materials in war time. Coupled with the fine coöperation of the public, these achievements of telephone engineers have resulted also in the efficient use of a minimum number of employees to furnish this service. The manner in which these results have been accomplished is an inspiring example of the fact that a team made up of the American public and American industry can always be depended on to be a winner in any common undertaking.

A Device for Accurate Aiming of Anti-aircraft Artillery, Developed by the Bell Telephone Laboratories and Made by Western Electric, Has Its First Demonstration

Electric Brain

Henry J. Kostkos

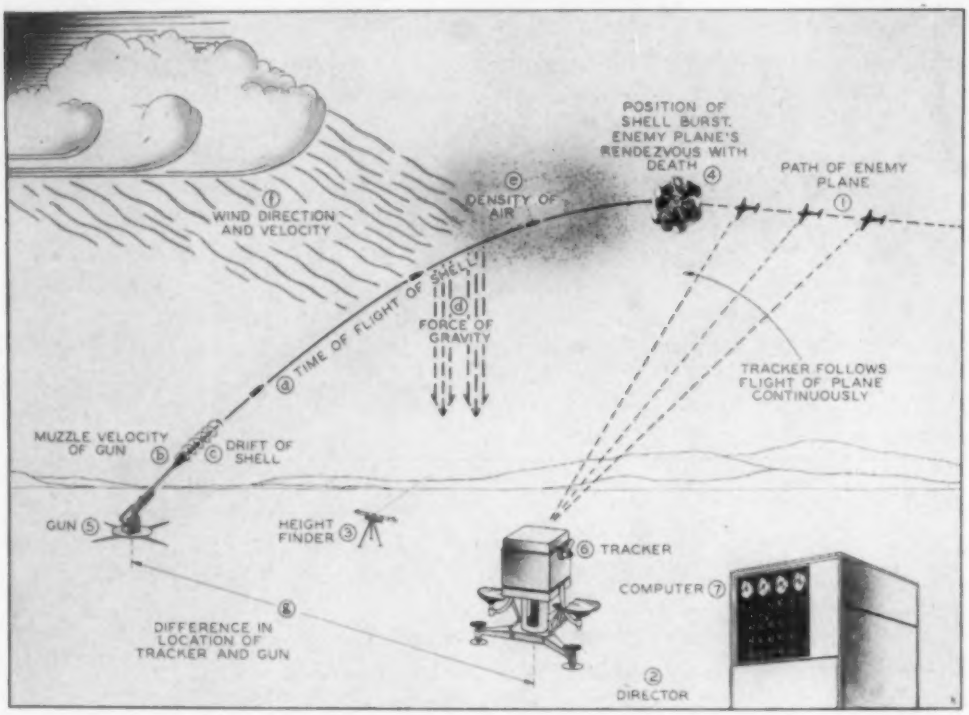
THE QUIET of New Jersey's Watchung Mountains in the vicinity of the Bell Telephone Laboratories' buildings at Murray Hill was shattered one early November afternoon when a column of big Army trucks, headed by an agile jeep, turned off the main road and rolled up the driveway leading to the Laboratories' spacious grounds. The driver of each truck knew the destination of his unit on the field that had been prepared for it, and smoothly landed it exactly there. With precision made possible only by constant coördinated drill half a hundred soldiers leaping from the caravan went into action simultaneously. They slipped off tarpaulins, unbolted gun carriages, assembled platforms. In a few minutes, four 90-mm. guns were ready for action against enemy planes.

At the same time other troops, specialists in their line, had set up, leveled, and adjusted the components of an electrical gun director system for fire control. Rifles swinging on straps over their shoulders, men in the detail unreeled wire and cable to tie together the power transmission and communication systems of a complete anti-aircraft battery. Machine gunners unloaded their weapons at strategic points around the grounds and stood on alert against attack.

But this was only mock warfare. The real use for the weapons that an anti-aircraft battery of the Eastern Defense Command of the Army had brought to the Bell Telephone Laboratories at Murray Hill for demonstration was on the battle fields in Europe, the islands of the South Seas, perhaps other parts of an embattled world too.

Two days later, on November 9, 1500 men and women of the Laboratories, distinguished Army guests, newspaper and magazine reporters and photographers, and representatives from other Bell System companies who had assembled on the Murray Hill grounds saw these weapons in simulated action against target planes. All of these events meant only one thing: the Bell Telephone Laboratories, using its years of com-

(*Please turn to page 259*)


POSITION OF SHELL BURST. ENEMY PLANE'S RENDEZVOUS WITH DEATH ④
PATH OF ENEMY PLANE ①
ⓔ DENSITY OF AIR
ⓕ WIND DIRECTION AND VELOCITY
ⓓ FORCE OF GRAVITY
ⓐ TIME OF FLIGHT OF SHELL
TRACKER FOLLOWS FLIGHT OF PLANE CONTINUOUSLY
MUZZLE VELOCITY OF GUN ⓑ
ⓒ DRIFT OF SHELL
GUN ⑤
HEIGHT FINDER ③
⑥ TRACKER
COMPUTER ⑦
ⓖ DIFFERENCE IN LOCATION OF TRACKER AND GUN
② DIRECTOR

DIAGRAMMATIC EXPOSITION OF THE FUNCTIONING OF THE SEVERAL UNITS COMPRISING THE BELL TELEPHONE LABORATORIES' ELECTRICAL GUN DIRECTOR:—

AN ENEMY PLANE, 1, looms in sight. The crews of the tracker, 6, and of the height finder, 3, spot the target and follow it in its flight. The computer, 7, of the electrical director instantly measures the position of the target and then predicts where the anti-aircraft gun, 5, is to be aimed and how the fuze of the shell is to be set so that the shell will burst in the path of the plane at the predicted position, 4.

The electrical information derived by the computer is translated into mechanical movement at the gun to swing its muzzle automatically to the correct horizontal and vertical angle to score a hit. Not only must the computer make its calculations continuously during the entire period the target is being tracked, but it must make constant and instantaneous corrections for these factors:—

The time of flight of the shell, a, to the predicted position of the target, 4, is dependent upon the muzzle velocity of the gun, b, which in turn is governed by the temperature of the powder and the number of times the piece has been fired. The ballistics of the shell is also influenced by its drift, c, which is the spin caused by the rifling of the gun, curving the shell to the right. At the same time the pull of gravity, d, deflects the shell downward, and the varying density of the air, e, slows down the projectile more or less; while the direction and the velocity of the wind, f, either retards or pushes the shell ahead or to one side. To add to the complications of the problem, the difference in the location of the tracker and the gun, g, must also be taken into account in making the computations.

munications background, its telephone "know-how," had applied these attributes to the problems of anti-aircraft fire control and had developed the M9 electrical gun director, which according to Major General L. H. Campbell, Jr., Chief of Ordnance ". . . is one of the greatest advances in the art of fire control made during the war."

Laboratories' School for War Training:

> "Almost exactly three years ago today final approval was given to proceed with the development of the electrical director now performing an important part in the control of anti-aircraft guns. Within about a year from that time, a model of the first director

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ONE OF the four anti-aircraft guns of the battery which at the Laboratories' demonstration was aimed by the electrical gun director. Directly behind it is the "tracker" and at the right is the "computer." In the right background appears some of the Laboratories' Murray Hill development

The demonstration was given with the approval and coöperation of the U. S. Army Ordnance Department and was occasioned by the third anniversary of the beginning of development work on the electrical director, as explained in the introductory remarks by R. Karl Honaman, Director of Bell Telephone

had been sent to the Army for test. Within another year the tests had been completed and the Western Electric Company was provided with the data necessary to begin production. Today, three years later, many of these instruments are in the hands of our armed forces."

Thus the Murray Hill grounds became a typical anti-aircraft position. Four 90-mm. guns formed a quadrangle. Dr. Harvey Fletcher, Director of Physical Research, explained to the audience that the guns are aimed and fired, either automatically or under control of the gunners, in accordance with information calculated and transmitted by the electrical director.

PRESS ASSOCIATION

DURING THE DEMONSTRATION at Murray Hill, President Oliver E. Buckley of the Laboratories (left) and Major General L. H. Campbell, Chief of Ordnance, manipulate the tracker as Dr. David B. Parkinson, originator of the concept, looks on

How the Device Operates

SIGHTING THE TARGET is done by means of a tracker. Two operators peer into telescopes, one on either side of the unit, and hold the cross hairs on the moving target by operating hand-wheels or by setting an automatic device that aids in the tracking. The man who follows the plane in azimuth—the horizontal angle—holds the vertical cross hairs on the target. In doing this the entire tracker, including the men on the seats, is rotated to follow the movement of the hostile plane. The second man elevates or depresses the telescopes by holding the horizontal cross hairs on the target—which may be rapidly changing its elevation. He thus determines the elevation angle. These two angular positions, which fix the direction of the target from the tracker, are automatically

and instantaneously converted into electrical terms by the device and transmitted to the computer.

In order to determine the exact position of the plane in space, the and controls, considers the present position of the target as well as its movement; and from the changes in the target's position, the computer determines the point in space where the

NEWARK STAR LEDGER

Two SOLDIERS operate the "computer" which automatically aims the guns and sets the shell fuzes. For a description of how the units pictured on this and the opposite pages function, refer to the diagram on page 258

range—straight-line distance—to the target must be added to the information provided by the tracker. This is done by means of a height or range finder and an associated altitude converter.

While the tracker and the height finder continuously sight the target, the electrical data from these instruments are sent over cables to the electrical brain, the computer. This complex device of electrical circuits, dials, plane will be at the moment a shell, fired at any instant, will reach it.

One of the most important functions of the computer is to make corrections for the ballistics of the gun and the outside forces acting upon the shell, such as gravity and wind. As shown in the diagram on page 258, the computer must consider all of these factors and come up with a solution not only instantaneously but continuously. To perform these com-

putations by the usual methods of using firing tables and slide rules would require so long a time that the enemy plane would have dropped its load of bombs and would be winging its way safely home.

In addition to pointing the battery of guns at the lethal spot in the sky, the computer provides information for setting the fuze to insure a shell burst at the predetermined point in space. One of the most important features of the electrical director is its ability to average or smooth out deviations in the course of the plane which are unavoidable even when the pilot is attempting to fly a straight course necessary during a bombing run.

Individual Initiative and Coöperative Effort

THE BASIC IDEA of the electrical gun director originated at the Bell Telephone Laboratories. It was in the middle of May, 1940, when the Panzer divisions were sweeping through the Low Countries and their Luftwaffe seemed invincible to the harrassed Allies, that Dr. David B. Parkinson of the Bell Telephone Laboratories technical staff conceived the idea of the electrical director. So logical did his solution to the anti-aircraft problem appear that in collaboration with his associate, Dr. Clarence A. Lovell, he immediately began to formulate his ideas in terms of electrical circuits.

The plans for the director he and his associates developed were reviewed by the Office of Scientific Research and Development in Washington and submitted to the Ordnance Department of the Army. The Laboratories were subsequently authorized to proceed with the building of a complete working model, and when the model arrived at Fort Monroe on December 1, 1941, a few days before Pearl Harbor, tests showed that the new electrical gun director did the job for which it had been designed and did it well.

Drawings and specifications were thereupon sent to the Western Electric Company, manufacturing organization of the Bell System, and mass production was begun. A satisfactory device of this kind requires not only good engineering design but also the application of the techniques of manufacturing necessary to produce a product which will stand up in field service. Here the long experience of the Western Electric Company in making telephone equipment for reliable performance in the Bell System has been applied to making these Directors dependable units in field service.

Although the basic idea for the electrical gun director was conceived by a few minds, its complete development was the product of coördinated effort. Dr. Oliver E. Buckley, President of the Laboratories, pointed this out in his address at the demonstration:

> "The electrical gun director involved in its development, design, and production the coöperation of many groups. Its progress in this regard was typical of many other hundreds of war projects on which we have worked and are working. In this case, a problem was recognized, and in seeking its solution inventions were made. As usually happens, both recognition of the

problem and the means for its solution came not from the top levels of the organization but from what I might call the productive level: in this instance, scientists of our physical research department. The importance of their findings was immediately recognized by the 'higher-ups.' "

In outlining the steps in the development of the electrical director, Dr. Buckley made note of the fact that this development followed the same series of functions normally performed on all new devices for the Bell System in ordinary peace-time activity of research and development. "Taking the user's point of view," he said, "we are vitally interested in reliability and life and also in ease and speed of maintenance."

In the case of the electrical gun director, the Army is the user. Its opinion is expressed in the remarks of General Campbell:

"As Chief of Ordnance of the Army I am certainly very much pleased to be standing here taking part in these ceremonies. I am especially pleased because we in Ordnance have always felt very close to the Bell Laboratories. We have been close for many reasons. The chief one of those, I think, is the fact that when we have wanted really high-grade, scientific work done we have come to the Bell Laboratories. . . . I often stop and think of the immense amount of effort involved to get an artillery projectile to an airplane. When we go back to the manufacture of the gun, the ammunition, the fire control apparatus itself, the training of the men, transportation over countless hundreds of miles of water and the dangers involved, then we must recognize the fact that the fire control is, after all, the heart of the whole proposition. If we can only control firing accurately, the rest will take care of itself, and that's why the work you have done in Bell Laboratories is, in our judgment, of such great importance. Do not underestimate what you are doing. We want you to know that we are all very proud of you and are looking for greater things."

"If you have sent returns under a name or an address differing in any particular from those used on this letter, please inform us, that our records may be corrected. Had Shakespeare worked with income tax files, he would not have dismissed so glibly the importance of a name. Doubtless a rose by any other name would smell as sweet, but when dividends are paid to Mary Jane Smith and reported to this office by Mrs. Thomas A. Smith, it is wellnigh impossible for those dividends to be identified."

From a letter from a state income tax department to an A. T. & T. stockholder concerning returns on dividends received.

Bombs Over Britain's Telephones

How England's telephone and telegraph services, and the men and women who operate them, faced up to the Nazi bombing raids of 1940 and 1941 is described by Mr. W. Chetham-Strode, Commercial Relations Division, Telephone and Telegraph Services, London, in a recent letter to Mr. D. M. DeBard, Vice President, Stone and Webster Service Corporation, New York. The following excerpts from that letter are published through the courtesy of Mr. DeBard.

THE FIRST ENEMY BOMB on the mainland of Great Britain since the 1914–1918 war fell near Wick in north Scotland on the night of April 10, 1940. On May 24 in the same year the first industrial town was attacked —Middlesbrough. The first bomb on the London area hit ploughland at Addington in Surrey on June 18, 1940.

In the eleven months from September, 1940, to the end of July, 1941, between 45,000 and 50,000 high explosive bombs fell on the London Region; incendiaries were numbered by the million.

During that September the attacks were concentrated on London. In the following month, however, they spread to the Provinces: to the Arms Towns—Coventry, Bristol, Sheffield, Manchester; to the shipping centres —Liverpool and Merseyside, Southampton, Cardiff, Portsmouth, Swansea, Plymouth, Belfast, Clydeside and Hull: to the quiet places of the agricultural districts and to the cathedral towns. Nearly everywhere the bombs came down, and they did not all fall harmlessly in fields and parks.

They fell on the railways and main roads; on houses, post offices and telephone exchanges. Telegraph and telephone communications were seriously interrupted. In the London area alone between September, 1940, and September, 1941, bombs fractured 1,695 cables. The repair of this damage meant the plumbing of nearly 3,000 joints and connecting more than 500,000 wires.

There is hardly a main road in the country without at least one cable somewhere beneath its surface. Frequently where cables converge towards the exchanges there may be as many as 100 buried below one thoroughfare. In the towns these often run alongside gas, water, electricity, sewer and other services—services which do not mix well when all are smashed by high explosives. And, on many occasions, they have been smashed and mixed together.

THE COMPANIES rule books issued to their engineers contain no sections dealing with what to do when a ton high explosive bomb hits a cable chamber and blows bricks and cables to fragments. So the men had to work out the answers to the questions as they went along. One bomb penetrated a road surface and destroyed

an underground tunnel through which two telephone cables ran. The tunnel was blocked to the roof with London clay. The circuits were temporarily diverted and the engineers faced up to another new problem—how to bridge the gap and join the ends of the cables again under the ground.

It would have taken too long to drive shafts from the road above to link up the broken ends, so they decided to bore through the clay.

They used a method known as "thrust boring," where a hand-operated hydraulic ram forces a strong steel rod through the ground until it has penetrated to the far end, when a steel tube is fastened to it and then pulled back again by the ram. It is a job that demands skill and experience even in favourable conditions. Here the conditions were far from favourable, as a sharp corner in the tunnel had to be negotiated.

The crater was full of debris from the road above and there was no way of anchoring the ram. But the effort had rather surprising success and the rod was driven through the clay to the far end of the obstruction. The worst part of the work seemed to be over. In fact, however, it had only just begun.

There was a slight down-hill slope at the far end of that tunnel, and sewage seeped through the crater and started to fill the hole; evil, stinking sewage. It was going to be a race against time to finish the repair work at the end of the tunnel before the water reached the roof.

The steel tube that was being pulled back became obstructed about half way and parted company with the boring rod: there was nothing else for it but to burrow through the clay to reach the pipe.

That work in the small tunnel was dangerous; the clay was likely to fall in and bury the men, the sewage was creeping ever higher, ventilation steadily worsened, and the tunnel looked like collapsing at any moment. The men carried on; they failed to reach the tube because of the obstruction it had fouled.

Another method was tried. Sweep rods were jointed and pushed through the steel tube and on through the wet clay to the other side. Where rods could go so could a small cable. Thus, by sheer hard physical effort, a hundred-pair cable was dragged through. By now the water was waist deep, but the cable was successfully jointed.

THAT WAS cable Number One. There still remained cable Number Two, with 254 pairs in it. The clay at the top of the tunnel appeared to offer less obstruction than on the floor, but a thrust borer could not be used other than at floor level. Therefore, the engineers drove steel piping through with sledge hammers, and a second cable was drawn through the hole.

All this time the air was becoming more foul and the sewage never ceased rising. There were incessant air raids, but the job had to be done because many of those circuits were vital.

The jointing was completed. There were seven feet of water and sewage in that tunnel when the last man was dragged out of it. The official report concludes with these words: "These men sought no reward but the satisfaction of knowing that

they had done well all that was asked of them. It was their privilege to restore to service vital communication circuits."

Some reports tell of lone men tackling jobs without help. There was one man of whom his supervising officer wrote: "His chief object in life appears to be to defeat the enemy." During one raid he was sent out to repair a severed main cable holding many circuits. He had to wade through icy water and grope about in the crater to find the broken ends. As he worked he heard another bomb falling immediately overhead, but the mud and his rubber boots barred any rush to safety. He threw himself flat in the filth as the bomb exploded across the street—then he carried on until the circuits were restored.

There was another case in which repairs had been pressed on hurriedly for several days when one of the men did a bit of digging to find out what the hard object was on which he kept treading. It was just covered with dirt at the bottom of the crater. He uncovered it: it was a heavy unexploded bomb.

IF WORK on the lines outside was hectic it was not exactly all quiet fun at the switchboards indoors. In Great Britain telephone exchanges are usually on the top floors of buildings where good light is obtainable. And many of them have glass roofs. However severe a raid may be, a nucleus staff remains in that switchroom to complete essential calls. And, in most cases, the staff do not comprise tough old ex-service men but girls and young women.

At one exchange a heavy bomb fell through the roof. It did not wreck the switchroom but tore a great hole in the blacked-out glass which meant that all lights had to be switched off to preserve the black-out. The "calling lamps" on the board were too bright to be used unshielded: enemy aircraft were overhead in hundreds and keen eyes were looking down seeking lights on which to drop their bombs.

A number of girls volunteered to stay on. Tarpaulins were draped over them and their instruments, and, under these, hot and stifled, they put through the calls. Their "Number, please?" mingled with the crashing of glass and the droning of the bombers. The raid lasted all night but the girls stuck it out.

OFFICIAL REPORTS are supposed to make dull reading but here is one given exactly as it was received at Headquarters in London—and it is not dull. "At 10.00 P.M. during a heavy raid volunteers were sought to go up to the roof switchroom. Two girls responded and ascended amid broken glass and rubble, their way being lighted only from the red glare of burning barges on the canal. A special call took fifteen minutes to mature owing to dislocation of the telephone services, but the important message was safely passed and the reply obtained with the guns in action throughout."

At some of the quieter country exchanges the work is done during the night by elderly caretakers. An exchange in a Yorkshire village is looked after by a seventy-four year old man and his wife. During one raid thousands of incendiaries fell in the neighbourhood, and hundreds of high explosives were dropped in a

raid that lasted for nine hours. But this old couple sat at their switchboard on the top floor of that country exchange and handled a flood of fire, ambulance and rescue calls. When asked why they did not take cover they answered that it had not occurred to them.

Just to sit there and carry on as though nothing was happening outside is not easy. The reactions of new operators during the first raid are always interesting. To one girl of 16 years of age who glanced around a little furtively when the bombs came down and the machine guns chattered, it was suggested that she might like to go to the basement for a while. But she replied, just as a bomb shook the building: "Oh no, I must see it through."

Probably telephone operators in Canada and America are trained to use set phrases while handling calls at the switchboard the same as the British operators, but mistakes do creep in now and again. It happened once at Dover, the town nearest to France. Dover has to put up with shelling in addition to the raiding aircraft. During one attack a newly trained telephonist was dealing with a call from a kiosk. As the first three minutes expired, the telephonist with one eye on the red time lamp and one ear turned to the falling shells, broke into the circuit to advise the caller "Your time is up, please." Outside events, however, must have gained control of her subconscious mind for just then a large shell exploded and she said, "Your number's up!" That gave the caller such a shock that it was a few seconds before he could regain enough control to ask for an extension of time.

And so the story could continue; the human side facing up to keeping the communications going however heavy the raids.

Damage to telephone exchanges has ranged from broken windows to a complete knock-out. The latter, fortunately, has been a rare occurrence, and, owing to the exercise of foresight and engineering ingenuity, alternative provision has been rapidly made.

The end is not yet, but the telephone and telegraph folk of Britain face the future with quiet confidence, and consider that they can keep communications going despite anything that the enemy may do.

Who's Who & What's What

(*Continued from page 207*)

Traffic Engineer of the Eastern Division last February, and since that division includes Philadelphia he at once found himself in the thick of the installation and preparations for the cut-over about which he tells.

SIMILARITIES between Army requirements for fixed communication facilities and the Bell System's toll plant naturally led Signal Corps engineers to enlist the interest of telephone engineers in the handling of some unusual problems. That is where ERNEST W. BAKER entered the picture, since for the past four years he

has been in charge of the group handling toll transmission matters in the assistant chief engineer's division of the A. T. & T. Company's Department of Operation and Engineering. After six years of plant engineering work with the Bell Telephone Company of Pennsylvania, Mr. Baker joined the O. & E. Department in 1930 and, except for a year and a half spent on other departmental assignments, has been in the transmission section since that time. It is an interesting coincidence that most of the contacts on "packaged carrier" with the Signal Corps' Plant Engineering Agency have been with Major A. M. Rose, a former Long Lines Department engineer; and it is obvious that a project of such size has also drawn upon many other Bell System men in the O. & E. Department, the Bell Laboratories, and the Western Electric Company.

THE PRIMARY PURPOSE of Information service is to make it possible to obtain the number of a telephone not listed in the directory. But many telephone subscribers have the habit of using this service to obtain numbers which *are* listed in the directory. This requires the provision of many more operators and more equipment than needed for the essential number service alone. How the Bell System has attempted to divert these additional employees and the associated equipment to vital war-time purposes is described by HOWARD F. PARKER, a member of the Traffic Engineer's division of the A. T. & T. Company's Department of Operation and Engineering since 1913. For several years after 1913, Mr. Parker was involved with the early development of the dial telephone system and with the preparation of the traffic engineering practices used for some of the first dial installations. Since 1927, he has been concerned with the engineering of manual central office switchboards, information desks and their associated records, and other related matters.

ACCLAIMED by Major General L. H. Campbell, Jr., Chief of Ordnance, U. S. Army, as one of the greatest advances in fire control made during this war, the electrical gun director developed by the Bell Telephone Laboratories and manufactured by the Western Electric Co. was featured by the press throughout the country following the first public demonstration of the equipment. HENRY J. KOSTKOS, of the Laboratories' Bureau of Publication, who helped plan the demonstration, tells about it in his article. It was in 1917 that Mr. Kostkos joined the Bell System as an installer for Western Electric. He later worked for the New York Telephone Company and the Southern Bell Telephone and Telegraph Company in plant assignments, and again for Western Electric as equipment engineer and supervisor of reports and publications. More recently he had been production planning engineer at the Kearny Works. Writing has long been his avocation, in the form of articles, fiction, stage and screen plays, so his present work —publicity connected with the war projects of the Laboratories—takes advantage of an "extra-curricular" skill.